DAIRYING

Instructional-cum-Practical Manual

Vol. III

Feeds and Feeding of Dairy Animals

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Project Coordinator

राष्ट्रीय शैक्षिक अनुसंधान और प्रशिक्षण परिषद्
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FOREWORD

The programme of vocationalization of higher secondary education has been accepted by the country as it holds forth great promise for linking education with the productivity and economic development of the country by providing education for better employability of the youth

In view of the importance of the programme, the NCERT is making an all out effort to provide academic support to the implementing agencies in the States One of the major contributions of the NCERT is in the field of curriculum development and in the development of model instructional materials. The materials are developed through workshops in which experts, subject specialists, employers' representatives, curriculum framers and teachers of the vocational course are involved. These materials are then sent for try-out in schools and feedback is collected through questionnaires and through direct contact The materials are also sent to experts for comments before they are published.

The present manual on Feeds and Feeding of Dairy Animals has been developed in the manner described above and is meant for the students studying Dairying and allied vocations. It is being published for wider dissemination amongst students and teachers throughout the country. I hope that they will find the manual useful.

I am grateful to all those who have contributed to the development of this manual I must acknowledge also the immense interest taken by Prof. A.K. Mishra, Head, Department of Vocationalization of Education in inspiring his colleagues in their endeavours to develop instructional materials. Dr. A K. Sacheti, Reader, functioned as the Project Coordinator for the development of this title in association with Dr A.K. Dhote, Lecturer. They have my appreciation and thanks for planning, designing and conducting the workshops and for technical editing.

Suggestions for improvement of this manual will be welcome

P.L. MALHOTRA

Director

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PREFACE

Ever since the introduction of vocationalization in the school system by several States and Union Territories in our country, the paucity of appropriate instructional materials has been felt as one of the major constraints in the implementation of the programme and a source of great hardship to pupils offering vocational studies at the Higher Secondary stage.

The Department of Vocationalization of Education of the National Council of Educational Research and Training, New Delhi, has started a modest programme of developing instructional materials of diverse types to fill this void in all major areas of vocational education. The task is too gigantic to be completed by any single agency but the model materials being developed by us might provide guidance and impetus to the authors and agencies desiring to contribute in this area. These are based on the national guidelines developed by a Working Group of experts constituted by the NCERT

The present manual is on Feeds and Feeding of Dairy Animals and is meant for the pupils and the teachers teaching Dairying and allied vocations, being offered in a number of States. It contains activities (Practical Exercises) to be performed by the pupils, with simple steps to follow, precautions to be taken and data to be obtained and processed. Each activity is complete with Objectives, Relevant Information, Behavioural Outcomes, Evaluation, etc. It is hoped that the users will find them immensely useful.

The manual was developed by a group of experts as contributors in a workshop held at the College of Animal Sciences, Haryana Agricultural University, Hissar, Haryana.

The name of the experts are mentioned elsewhere and their contributions are admirably acknowledged. Dr. A.K. Sacheti, Reader and Coordinator of this project and Dr. A.K. Dhote, Lecturer, Department of Vocationalization of Education deserve special thanks for editing and bringing the manual in the present form. The assistance of all in the College of Animal Sciences, Haryana Agricultural University, Hissar, Haryana, and the Department of Vocationalization of Education, NCERT, New Delhi, is also gratefully acknowledged

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1. Dr. V.D. Mudgal
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6. Dr. A B. Mandal
7. Dr A.K Dhote and
8. Dr. A.K Sacheti

ABOUT THE MANUAL

Under the programme of Vocationalization of Education, about 20 different groups of vocational courses in the area of agriculture have been introduced by the implementing States and Union Territories so far. These courses have been running for the last nine or ten years. From the very beginning, the Department of Vocationalization of Education in the NCERT has been working hand in hand with the State organizations concerned, through various programmes organized for State officials, vocational teachers, and others. In fact, the Department has conducted on-the-spot studies of vocational programmes in quite a few States, to find out the merits and demerits of the programme and to suggest appropriate measures to resolve the problems in 'vocational agriculture education'. These problems have revealed that there was a great dearth of suitable textual/instructional materials; the need for practical manuals, especially, was urgently felt. The development of instructional materials and the imparting of practical training become even more important when one considers the purpose for which the vocationalization of the education programme has been launched. The main aim of the programme is to prepare the pupil for purposeful and gainful employment. (wage-earning or self-employment).

The Department constituted a Working Group during the year 1982 to formulate guidelines for developing models for a variety of instructional materials

Based on the guidelines formulated by the Working Group, Dairying, which is an important and popular vocational course in agriculture, was selected by the Department for the purpose of development of instructional materials in a phased manner. To begin with, the development of instructional-cum-practical manuals has been taken up.

The content of Dairying and similar courses offered by the States and Union Territories under different titles was thoroughly analyzed and it was felt that six manuals would be necessary to cater to the needs of the course The present manual on Feeds and Feeding of Dairy Animals is one of them. The manual is intended to help both teachers and pupils in the study of feeds and fodders, determination of nutrients, detection of adulterants, preparation of cattle feed, milk replacer, calf starters, computation of rations and activities related to the organization of a feed analysis laboratory as preparation for this vocation While developing the manual, care was taken to include all the practicals (Activity Units) based on Minimum Competencies Based Curriculum for dairying developed by the NCERT and States syllabi.

These Activity Units are essential to develop the required vocational skills in the pupils. The manual explains in detail the 'what', 'why', and 'how' of these Units.

In the manual, each Activity Unit has been dealt with under several sub-heads, viz. Instructional Objectives, Relevant Information, Precautions, Materials Required, Procedure, Observations, Expected Behavioural Outcomes and Questions.

Before commencing the actual work under any Activity Unit, the teacher should know what exactly the pupils have to learn and do, and should also assess whether they will be able to do it. Therefore, in the beginning, instructional objectives for the pupils should be framed in behavioural terms by the teacher

In order to acquaint the pupils with the Activity Unit, the teacher should provide them with the required theoretical knowledge or information relevant to the activity. This will help the pupils to properly understand the Activity Unit. In other words, the 'what' and 'why' parts of the Activity Unit should be explained in advance by the teacher.

Once the pupils have understood the relevant theoretical instructions, the teacher should tell them about the precautions which are to be taken before and during the actual execution of the Activity Unit This will facilitate smooth working. The 'how' part of the Activity should be explained by the teacher in the 'Procedure' which pupils should follow while performing the Activity Unit.

Under the sub-head 'Observations', the teacher should tell the pupils what to observe and in view of that, they should observe the situation, take readings, note down the temperature and similar other points, under each Unit; these may vary from Unit to Unit Whatever calculations are required to be done to obtain results, this should also be indicated under this head or under a separate head.

At the end of the Activity, the pupil will have acquired certain abilities which should be closely related with the Instructional Objectives formulated for each Activity Unit. These abilities should be listed under the sub-head 'Expected Behavioural Outcomes'. Evaluation should be based on the abilities acquired and it should be done by the teacher concerned.

For evaluating each aspect, the teacher will use a four-point scale, i.e., A, B, C & D, and for each Activity Unit, the Grade Point Average can be calculated as indicated below:

Supposing there are four aspects, each carrying equal weightage, and a pupil obtains 2As, 1C and 1D and if A=4 point, B=3, C=2 and D=1 point; then, based on the grades, the pupil will get 11 points. When the number of points obtained is divided by the total number of aspects examined, it will give the Grade Point Average, which, in this case, is 2.75. The tabular presentation is as under.

Aspects	*Weightage*	*Grades Obtained*	*TOTAL POINTS (weightage X point equivalent to grade obtained)*	*Grade Point Average*
1	1	A	1 × 4 = 4	
2	1	C	1 × 2 = 2	
3	1	D	1 × 1 = 1	
4	1	A	1 × 4 = 4	
			11	= 11/4 = 2 75

At the end of the Activity Unit, some questions relevant to it are also given.The pupils should write the appropriate answers after the completion of the Activity Unit and teacher should examine these If required, he should make suitable corrections and give suggestions However, answers to these questions will not be considered for the purpose of grading

CONTENTS

INTRODUCTION

The nutrients in a feed-stuff enable the animal body to perform the vital processes of life and provide the material to replace the essential tissue breakdown which occurs continuously in the body. Feed also provides the constituents and energy required for body growth.

All the feeds supplied to animals contain water, proteins, fats (ether extract), crude fibre and soluble carbohydrates (nitrogen-free extract). In addition to this, they also contain mineral matters and vitamins.

In order that a dairy cattle or buffalo grows, reproduces, maintains the body tissue, produces milk and stays healthy, protein must be present in dairy rations. After meeting the body needs, the excess protein is used as a source of energy. It is, therefore, very important to feed the requisite amount of protein required for the animal, particularly when protein costs more than the energy part. Cows and buffaloes, unlike poultry and swine, utilize poor quality proteins or non-protein nitrogen compounds (urea), because bacteria and protozoa in the rumen can form essential amino acids that are required by the animals.

Carbohydrates and fats are the chief sources of energy in dairy rations. They supply energy to carry on the life processes and help in growth and the production of milk. If the dairy rations do not contain enough energy, protein that might otherwise be used for maintenance, growth or milk production, is used for energy. To avoid this uneconomic use of nutrients, there should be a balance between protein and energy in the diet. A major portion of the energy needs of high production cows and buffaloes goes for milk production. Adequate supplies of energy are particularly important during the early part of lactation. Fats present in the usual rations appear to be adequate for dairy animals. Unless fats and oils are cheaper sources of energy, there is little economic advantage in feeding fats in addition to what is normally present.

Minerals are required for growth, maintenance and milk production in dairy animals. Growing and milking cows and buffaloes need large amounts of minerals,

especially calcium and phosphorus. In addition to calcium and phosphorus, sodium, chlorine, iron, iodine, magnesium, copper, manganese, cobalt and others are essential for dairy cows. These are usually supplied in sufficient amounts in the regular rations. Forage, unlike concentrate, is high in calcium and low in phosphorus content. High protein feeds (bran and oilcakes) contain more phosphorus. Lesser intake of salt might result in lower milk production.

All vitamins, except Vitamins A, D and E, needed by cows and buffaloes, are synthesized in the rumen. It is, therefore, necessary to ensure that these vitamins are adequately supplied in the dairy rations. The principal sources of Vitamin A are green forage, good quality hay and silage. Vitamin D which is essential for maintenance and milk production in mature dairy animals, is supplied in adequate amounts by exposure to sunlight. Vitamin E is available from forages and concentrates, when supplied adequately.

Water is the most important ingredient of dairy cattle rations. For maximum growth and milk production, dairy animals should have access to clean and fresh water at all times. Supply of water is as important in winter as in summer.

The chemical composition of feeds should be known for formulating rations based on their nutritional value. It is also used for checking possible adulterants in feed-stuff. A proximate system of analysis is the starting point of determining specific chemicals of feed entities. It provides proximate nutritive composition of a given feed. The principle of analysis is to separate feed-stuffs into various organic and inorganic fractions i.e. water, protein, fat, fibre, soluble carbohydrates and minerals. In standard estimations, only five of these proximate principles, i.e. moisture, ether extract (crude fat), crude fibre, crude protein and ash, are determined. The nitrogen-free extract is, thus, calculated simply by difference.

Of all the livestock, the dairy animal is known as an efficient producer of foods for man. It can utilize large quantities of feed, much of which human beings cannot use in its natural state. The economical production of milk, however, depends largely upon three general factors, i.e. the efficiency of an animal, its nutrition and care. The efficient cow/buffalo is the result of inheritance. An animal with the desired characteristics is obtained by selection and or by improved breeding. Proper attention to the selection of the individual animal and to breeding, ensures that an efficient animal system is available for milk production. The productivity, however, depends upon the adequate inputs in terms of feeds and care available to that animal.

Since feeding contributes the major item of cost in milk production, it is important that feed cost are kept at the lowest possible level to make production profitable. Thus, the more one knows about feeds and feeding in relation to dairy animals, the greater will be the effort in improving the efficiency of milk production.

Selecting the correct feeds, using the right combination of feeds, giving the adequate amount of feeds and many other related practices are some of the ways which will enable the farmer to feed his cows or buffaloes more economically, increase their efficiency and make the dairy more paying. It is, therefore, necessary to ensure that the animal receives the required quantity and quality of feeds to produce milk economically.

A student of Dairying, after acquiring knowledge about the various feeds and fodders and their composition, should be able to formulate balance and economic rations for various categories of livestock. A point to be noted is that the nutrition of young calves is entirely different from that of adult cows and buffaloes in terms of both quality and quantity. While the adult cows and buffaloes are able to utilize the fibrous feeds and fodders, the young calves require more energy and protein per unit of weight of the feed. All these aspects have been covered in this Instructional-cum-Practical Manual on Feeds and Feeding of Dairy Animals.

ACTIVITY UNIT · 1

Identification of Various Feeds and Fodders, Including Feed Supplements

1.1 Instructional Objectives

The pupil should be able to:

- recall the role of various categories of grasses and fodder trees;
- recall various types of cultivated fodders;
- differentiate between leguminous and non-leguminous fodders;
- differentiate between concentrates, roughages and feed supplements;
- differentiate between dry fodders, green fodders and silages;
- identify various feeds, fodders and feed supplements.

1.2 Relevant Information

(a) *Importance of identification*

Identification helps in grouping of various classes of feeds on the basis of bulk and composition. Various feeds can be classified into three main categories:

(i) *Roughages*: are normally whole-plant materials of high fibrous content which form the bulk of the rations fed to animals. There are several types—such as hay, silage, green fodder, pasture, etc. The distinguishing characteristic of roughage is usually a high fibre content. For hay, this frequently runs between 25 and 30 per cent of the dry weight. Roughages can be further classified into dry roughages (straw, hay, *kadbi*), silage (oat, maize, etc.) and green roughages. Green roughages may be of two types i.e. leguminous (lucerne, cowpea, berseem, etc.) and non-leguminous (oats, maize, sorghum, bajra, teosinte, etc.). In addition, the roughages include grasses and fodder tree leaves and branches. Grasses may be cultivated (para, hybrid Napier) and non-cultivated (*dub* grass).

Leguminous fodders are rich sources of crude protein and minerals, specially calcium, whereas non-leguminous fodders are comparatively rich in energy content. For example, berseem and lucerne are rich in protein and calcium, but maize and oats fodder are rich in energy content *Silage*. is the green material produced by controlled fermentation of green fodder crops, retaining the high moisture content Fresh fodder is packed in a silo (container) and allowed to ferment under anaerobic conditions. Two types of silos are prepared—tower silos and pit silos. The feed is kept airtight for preserving its nutritive value. The process of conserving green fodder as silage is called ensiling. The important fodder crops which are used for silage making are maize, oats, jowar, bajra, teosinte, etc.

(ii) *Concentrates:* All feeds supplying primary nutrients (protein, carbohydrate and fat) are classed as concentrates if their crude fibre content does not exceed 18 per cent. Concentrates are normally of two origins: one from vegetable sources and the other from animal sources. Concentrates from vegetable sources are grains like maize, barley, oats or byproducts of various grains like wheat bran, rice bran, rice polish, gram *churi*, *dal chuni* and oilseed cakes (groundnut, mustard, till linseed, etc. Examples of concentrates from animal sources are fish-meal, blood-meal, meat-meal, etc. Concentrates of animal origin are generally fed to pigs and poultry.

(iii) *Feed supplements:* These are concentrated sources of feed nutrients, such as protein, minerals or vitamins. Individual feed ingredients that contain 20 per cent or more of protein are included in the supplement category. Any mineral or vitamin carrier added to the rations is normally referred to as a supplement. Various feed supplements are protein supplement, vitamin supplement, mineral supplement and antibiotics.

(b). *Characteristics of some important feeds*

I. LEGUMINOUS CULTIVATED CROPS

(i) *Berseem (Trifolium alexandrinum L.)*, also called Egyptian clover is an important leguminous fodder crop. It is a high yielding, succulent, palatable and nutritious fodder. In the northern part of India it provides fodder from November to May, in six to seven cuts. It contains 15-20 per cent crude protein on dry matter basis.

(ii) *Lucerne (Medicago sativa)* is a perennial leguminous crop. Once grown it continues to supply nutritious fodder for 3-4 years. This crop supplies green fodder during the lean summer months of May and June when there is no berseem in the fields. The fodder contains about 15-

18 per cent of protein. Apart from the perennial types, there are also annual types which can be sown in the month of October and harvested in June-July, and rotated with crops like jowar, maize, bajra and paddy.

(iii) *Cowpea* (*Vigna* species) is a very important, quick growing legume, which fits well in the crop rotation. It contains 10-15 per cent crude protein on dry matter basis.

II. NON-LEGUMINOUS CULTIVATED CROPS

(i) *Maize (Zea mays* Linn) is the most nutritious, succulent and palatable fodder crop among the cereals, grown during the summer and rainy seasons. The yield during summer months does not exceed 300 quintals per hectare. In the monsoon months, the yield may go up as high as 450-500 quintals per hectare. The crude protein content is about 8 per cent on dry matter basis, whereas total digestible nutrients are 60 per cent, which are higher than in leguminous fodder crops.

(ii) *Oats (Avena sativa)* is one of the important fodder crops grown in the winter season in Northern, Western and Central India. It is a quick growing, palatable, succulent and nutritious crop and forms an excellent combination when fed along with other cold season legumes like lucerne and berseem. It contains 7-9 per cent crude protein on dry matter basis.

(iii) *Sorghum or Jowar (Andropogon sorghum)* can withstand heat and drought to a much greater extent than maize. It is one of the most important kharif season fodders and contains about 4-5 per cent crude protein. The average yield is 500 quintals per hectare under irrigated conditions.

III. CULTIVATED AND NON-CULTIVATED GRASSES

(i) *Napier grass (Pennisetum purpureum)* is a prolific yielding non-leguminous perennial type of fodder crop. The plant tillers freely and a single clump may produce more than 50 tillers under favourable climatic conditions. It contains 6 per cent crude protein and 55 per cent total digestible nutrients. The grass is rich in oxalates, the content of which goes down with advancing maturity.

(ii) *Para grass (Brachiaria mutica)* is a rapid, summer-growing perennial crop. It produces runners and is ideally suited for heavy rainfall areas. It grows well on the boundaries of ponds, tanks, ditches and canals. It contains between 10-12 per cent crude protein.

(iii) *Dub (Cynodon dactylon)* is non-cultivated grass and a good soil binder. It grows on uncultivated land and is an important pasture grass containing about 10 per cent crude

protein It is liked by cows, buffaloes and other animals.

(iv) *Johnson grass or Baru grass (Sorghum relepensic)* is a poor quality fodder containing about 4-5 per cent crude protein It is actually a weed and found in fields of sorghum and bajra It is rarely grown as a fodder crop.

IV. BROWSE SHRUBS AND TREE LEAVES

(i) *Koo Babul (Leucaena leucocephala)* tender branches contain 18-20 per cent crude protein on dry matter basis. It is a perennial tree/shrub. Its seeds can be used as one of the ingredients in concentrate mixtures. This is suitable for cows, buffaloes and goats but not for sheep, pigs and horses, on account of the toxic amino acid mimosine.

(ii) *Jharberi (Zizyphus* species*)* grows mostly in Rajasthan and some parts of Gujarat and Haryana. It is good fodder shrub liked by goats and sheep and may be used in the rations of cows and buffaloes also. It contains 15-20 per cent crude protein on dry matter basis. Its dry leaves are used as a supplemental feeding.

(iii) *Fodder tree leaves*. Khezri (*Prosopus cinararia*), Mulberry (*Morus indica*), Poplar (*Poplas hibrida*), Pipal (*Fiscus religiosa*), Neem (*Azadirachta indica*), Bargad (*Ficus bengalensis*), Babool (*Acacia arabica*), Beri (*Zizyphus jujuba*), etc. are commonly used for feeding to cattle, sheep and goats. They are good sources of feed nutrient in times of scarcity.

1.3 Precautions

— Take representative samples of various feeds.

— Keep each sample separately; avoid mixing them up with each other.

— Use fresh samples only for identification of green fodders and silage.

— Ensure that the concentrates and other feed samples are free from fungal/bacterial infection and adulterants.

1.4 Materials Required

(i) Green fodder plants, either leaves or small portions of plants such as lucerne, berseem, maize, oats, sorghum, bajra, cowpea, para grass, Johnson grass, Napier grass, dub grass.

(ii) Dry fodders, like wheat straw, paddy straw, berseem hay, lucerne hay.

(iii) Concentrate ingredients: samples of grains like maize, barley, oats, and of byproducts like wheat bran, rice bran, rice polish, groundnut cake, mustard cake, linseed cake, til cake, fish meal, blood-meal, bone-meal, mineral mixture.

(iv) Petri dishes or glass bottles

1.5 Procedure

— Arrange the specimens (feeds,

fodders, concentrates) separately and study them for the following characteristics:

(i) *Green fodders*
Height of the plant, size of leaves, shape of leaves, colour of leaves, leaf surface, leaf margin, leaf-stem ratio (by weight).

(ii) *Dry fodders*
Same as for green fodder.

(iii) *Concentrates*
Type, colour, size, any special characteristic.

1.6 Observations

The pupil should examine the specimens carefully and record the findings in the tables given below:

(i) Green fodders

S. No.	*Name*	*Height*	*Leaf Size*	*Shape of leaf*	*Colour*	*Surface of leaf*	*Margin of leaf*	*Leaf. Stem ratio*
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*

(ii) Dry fodder

S No.	*Name*	*Height*	*Leaf size*	*Shape of leaf*	*Colour*	*Surface of leaf*	*Margin of leaf*	*Leaf·Stem ratio*
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*

(iii) Concentrates

Type	*Colour*	*Size*	*Shape*	*Any Special characteristics*
1	*2*	*3*	*4*	*5*

1.7 Expected Behavioural Outcomes

The pupil will be able to:

Grade

— identify important fodders, concentrates and feed supplements;
— differentiate between the concentrates; roughages and feed supplements;
— differentiate between leguminous and non-leguminous fodders;
— assess the role of various grasses and fodder trees in animal feeding.

The teacher should evaluate the pupil for the above abilities.

1.8. Questions

(i) Tick mark (✓) the correct answers:

a. Concentrates contain less than 4/14/18 per cent crude fibre.
b. Feed supplements are a rich source of mineral/vitamins/-protein/all the three.
c. Hay usually contains 25-30/18-30/30-40 per cent fibre.

(ii) Fill in the blanks:

a. Leguminous fodders are a rich source of . . . . . .
b. Non-leguminous feed is generally rich in . . . . . .
c. . . . . are leguminous fodder crops.
d. Important fodder trees are . . . . . .

(iii) Which fodder out of the following, is the best: green, dry, silage.

ACTIVITY UNIT : 2

Sampling and Labelling of Feed, Fodder, Urine, Faeces and Blood

2.1 Instructional Objectives

The pupil should be able to:

— recall the importance of the sampling technique;
— recall the amount/size of the sample needed;
— draw the sample for different purposes;
— label and preserve the samples.

2.2 Relevant Information

Sampling of feeds :

Since the samples form the basis for analysis, utmost attention should be paid to drawing out the samples. It is generally found that the raw materials obtained are not of uniform quality. The samples should be drawn from the centre as well as from the periphery of the gunny bags. It is better to draw samples from all the bags. If the consignment is large, then a standard sampling procedure should be followed. The quantity of each sample, number of samples and percentage of bags to be sampled is proportional to the size of the consignment.

Preparation of samples :

The preparation of the sample depends upon the purpose of the analysis and nature of the constituents that are to be determined. Most fresh feeds contain a large proportion of water. Some analytical determination is made directly upon fresh material while others are made upon dried materials only. Dried materials can be safely and conveniently stored and used for analysis. The prepartion of plant material for analysis is just as important as the analytical procedure and should be carried out with the same careful attention. The general procedure followed is outlined below:

Segregation of tissues: It is necessary to mix all the parts of a

plant into a composite sample for analysis for the determination of the total nutrient value of a feed or forage. Corresponding plant parts from more than one plant may be composited to obtain representative sampling or samples of sufficient size, for analysis.

Cleaning of tissues. Plant tissues, particularly from the lower portions of field grown plants, are often contaminated with soil or other materials Before analysis, these must be removed as completely as possible. During the operation of harvesting, plants intended for analysis should not be laid on the ground.

Sub-dividing sample: The original sample should be divided into three different portions and the various estimates should be done as detailed below:

Quantities of samples for estimation

The following are the approximate quantities of samples of feed/fodder taken for proximate analysis.

For moisture determination:

(a) About 10 g for concentrate and dry roughages.
(b) About 50-100 g for green fodders and leaves.

For estimation of total ash

(a) Quantities as for moisture determination.

For estimation of ether extract:

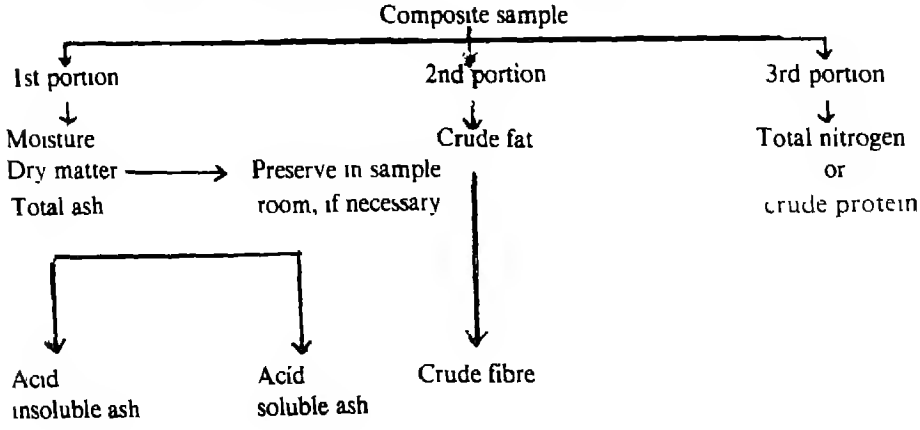
(a) 2 g for oilseeds and oilcakes.
(b) 3-5 g for cereal grains and pulses.
(c) 6-10 g for dry roughages like straw and hay.

For estimation of crude fibre:

About 2 g, fat free and moisture free.

For estimation of crude protein

(a) About 0.5-1 g for oilcakes, fishmeal, guar-meal and other protein supplements.
(b) About 1.5-2 g for grains.
(c) About 2-3 g for dry fodders.
(d) About 10 g for green fodders and leaves.



Grinding dry feeds:

Dry material is commonly ground to a fine powder before analysis to ensure representative sampling. Mechanical mills are best for this purpose. It is important that the mill be thoroughly cleaned between the grinding of individual samples. All the samples should be ground and screened and then thoroughly mixed.

Labelling

Ground samples should be stored in clean bottles or polyethylene vials fitted with tight covers and should be clearly and correctly labelled. A code number may be used for labelling. Detailed information must also be written in a sample register, using the following format:

autions

— Collect an adequate amount of sample from all corners and the centre of the bag.
— Avoid contamination and atmospheric exposure.
— Carry out sample preparation as quickly as possible.
— Avoid loss of moisture from wet samples.
— Determine dry matter content immediately after receiving the sample.
— Do not pack green fodders tightly in a container during drying.
— Avoid overheating of the sample.
— Clean the mill thoroughly before grinding.
— Preserve the samples in clean bottles or polyethylene vials.
— Label the sample with code number/name.

Sr No	*Identification/ Name of the sample*	*Date of receipt*	*Name of the person/Institute with complete address from whom of from where the sample was received*	*Analysis to be done for*
(i)				
(ii)				
(iii)				

2.4 Materials Required

(i) Large plastic bags
(ii) Large paper bags
(iii) Sampler
(iv) Chopper/sharp knives/ dissecting scissors
(v) Weighing balance and weight box
(vi) Measuring cylinder

(a) *Reagents*
(i) 25% H_2SO_4 (W/V)
(ii) Anti-coagulants (Heparin/ EDTA)

(b) *Apparatus*

(vii) Bucket
(viii) Tray
(ix) Bottles (glass/polyethylene)
(x) Spatula
(xi) Shovel
(xii) Spade
(xiii) Trough
(xiv) Hot air oven
(xv) Mechanical mill (grinder)
(xvi) Mixer/blender
(xvii) Glass vials
(xviii) Label strips

2.5 Procedure

(a) *Sampling of feeds*

— Take out samples from each gunny bag and collect in a large plastic bag/paper bag.
— Dry the sample and record dry matter content (refer to activity Unit 5)
— Grind the whole sample in a large mill through 10 mash screen.
— Mix the sample properly.
— Allow the ground material to equilibrate with air overnight.
— Place the ground sample in clean bottles/polyethylene vials fitted wth tight covers.
— Label the sample clearly and correctly.
— Preserve it in the sample room.

(b) *Sampling of fodders*

— Collect more than one plant to get sufficient size or amount of sample for analysis.
— Remove all contamination like soil and other materials by gentle brushing.
— Cut the sample immediately into small pieces (2.5 cm) with a sharp knife or scissors and mix thoroughly.
— Weigh the sample.
— Dry the sample in a hot air over at 100°C and estimate the dry matter content of the sample (refer to Activity Unit No. 5).
— Grind the sample in a grinder, screen and mix thoroughly.
— Allow the ground material to equilibrate with air overnight.
— Place the sample in an air tight container, and label clearly and correctly.
— Preserve it in the sample room for analysis.

(c) *Sampling of faeces*

— Collect the faeces voided daily, in a bucket
— Weigh the total faecal output.
— Mix thoroughly by hand on clean surface/troughs.
— Sub-sample 1.0 per cent of wet weight in a plastic container/bottle and label it.
— Store in a freezer/cool place after adding adequate but

known quantity of 25 per cent H_2SO_4.

Sub-sample another 1.0 per cent of wet weight in a tray of known weight and keep in a hot air oven for drying.

Record the dry matter content (Activity Unit No 5) of the faeces.

— Grind the sample in a milk, screen and mix properly.

Store the dry faces in polyethylene bottles (vials) with clean and correct labelling.

(d) *Sampling of urine*

— Collect urine excreted daily in a large bottle through urine collection device.

— Mix the urine and measure the volume.

— Shake well and sub-sample 1 per cent in a polyethylene bottle fitted with a tight cover.

— Add 10 ml of 25 per cent, H_2SO_4 to the bottle containing urine.

— Cover the bottle tightly, label correctly and preserve in a cool place/freezer.

(e) *Sampling of blood*

— Restrain the animal from which blood is to be drawn.

— Shave the hair from the site (jugular vein) on the skin with a razor.

— Clean the site with 70 per cent alcohol and rub for drying.

— Puncture the jugular vein with the help of 16 or 17 gauge stainless steel needle.

— Discard the first few drops of blood and then collect it in a suitable container (dried) slowly, without force and avoiding mixing of air.

If whole blood/plasma is needed, collect blood in a tube having anti-coagulants (Heparin @ 0.2 mg ml of blood or Ethylene Diamine Tetr Acetic Acid—EDTA @ 1 mg/ml). Rotate to dissolve the anticoagulant. Centrifuge the whole blood and remove the plasma with a rubber bulb pipette.

— If serum is needed, draw blood into a tube without anti-coagulant. Allow blood to clot keeping the tube in a slanting position. Then chill the tube in a freezer overnight in an upright position. Pour off the serum from the side of the tube opposite the slanting clot

— Collect the plasma/serum in glass vials.

— Label properly and correctly.

— Preserve the sample in a freezer.

2.6 Observations

The pupil should record the following:

(a/b) *With regard to feeds and fodders:*

— All observations related to dry matter estimation (refer to Activity Unit 5 item Nos. 5.6 and 5.7).
— Proper labelling on the preserving bottles with date and code No./ name of the sample.
— Ensure proper entry in the sample register.

(c) *With regard to faeces:*
— All observations related to dry matter estimation (refer to Activity Unit 5 item No. 5.6 and 5.7).
— Weight of the preserving bottle = g
— Weight of the wet faeces taken = g
— Amount of 25% H_2SO_4 (W/V) added = ml
— Weight of the bottle plus whole contents = g
— Labelling on the bottles with date of collection.
— Proper storage in cool place/ freezer

(d) *With regard to urine:*
— Amount of urine taken in bottle = ml
— Amount of 25% H_2SO_4 (W/V) added = ml
— Proper labelling on the bottle with date of collection
— Proper storage in cool place/ freezer

(e) *With regard to blood:*
— Proper labelling on the bottle indicating date of collection and nature of the sample i.e. serum/ plasma
— Proper preservation in a freezer.

2.7 Expected Behavioural Outcomes

The pupil will be able to:
— recall the amount of sample of different materials needed;
— draw the different samples i.e. feeds, fodders, faeces, urine and blood;
— prepare the sample for preservation and analysis;
— label and store the samples for future analysis;
— maintain the records of samples received and their analytical results.

Grade

The teacher should evaluate the pupil for the above abilities.

2.8 Questions

i. Why should loss of moisture from the fresh sample be avoided?
ii Why should contamination during sampling be avoided?
iii. Why is overheating avoided during drying?
iv. How will you collect samples of a compound feed?
v. Why is 25% H_2SO_4 is added in preserved faeces and urine?
vi. Can you use 25% HNO_3 instead 25% H_2SO_4 for preservation of urine/faeces?
vii. What is the difference between plasma and serum?
viii. Name any two anti-coagulants used for collection of blood.
ix. What is a composite sample?
x. Why is labelling done?

ACTIVITY UNIT: 3

Acquaintance with Various types of Laboratory Equipment and Apparatus and Cleaning of Glassware

3.1 Instructional Objectives

The pupil should be able to:

- identify the various laboratory equipment and apparatus;
- explain the functions of various laboratory equipment and apparatus;
- handle the various equipment and apparatus,
- recall pre-and post-operative care;
- clean glassware.

3.2 Relevant Information

Various types of equipment and glassware are used in the laboratory. It is essential to know the functions and handling procedure of the different types of equipment.

General information regarding instruments/ apparatus:

Refrigerators: Should be explosion-proof when used for storage of ether and other highly volatile, inflammable liquids.

Fire extinguishers: Dry-chemical fire-extinguishers should be provided for each laboratory room. The workers should be familiar with their location and use.

Care in handling electrical equipment:

Electrical wiring connected with equipment should be grounded to avoid electrical shock Mechanical injury should be avoided by proper handling of the equipment. Installation, maintenance and repair operations should be performed by qualified electricians.

Cleaning of laboratory wares:

The glass and porcelain items should be thoroughly washed with detergent, extensively rinsed with tap water followed by further rinsing

with small amounts of distilled water.

If a film of grease remains after thorough cleaning with the detergent, a cleaning solution consisting of sodium or potassium dichromate in concentrated sulphuric acid may be used. After the use of this solution, extensive rinsing is required in order to remove the last traces of dichromate ions which adhere strongly to glass or porcelain surfaces.

Preparation of cleaning solution

Mix 10 to 15 g of potassium dichromate with about 15 ml of water in a 500 ml conical flask. Add concentrated sulphuric acid slowly and stir thoroughly. Add enough sulphuric acid to bring the mass into solution

Note.

(i) The cleaning solution should be discarded when it acquires the green colour of chromium ion

(ii) The cleaning solution is most effective when warmed to about 70°C. At this temperature it will rapidly attack plant and animal matter and is, thus, a potentially dangerous preparation.

(iii) Any spillages should be diluted promptly with copious volumes of water.

3.3 Precautions

Handle the equipment/apparatus with care.

Avoid use of equipment for purposes other than the designated ones.

— Keep the instruments clean and functioning.

— Put off the electric supply before closing the laboratory unless it is required for some particular equipment.

See that all the equipment has a proper and sound electric wiring with shoes and plugs.

— Handle the cleaning solution carefully

3.4 Materials Required

(a) Some laboratory equipment/apparatus and their functions:

	NAME OF EQUIPMENT	FUNCTION
(i)	Balance	Weighing
	(a) Physical	— do —
	(b) Chemical	— do —
	(c) Electrical	— do —
	(d) Top-pan	— do —
(ii)	Oven	Drying the samples and glassware
(iii)	Muffle Furnace	Ashing the samples
(iv)	Lyophilizer	Freeze-drying of samples
(v)	Shaker	Shaking the samples
(vi)	Water bath-cum-shaker	Shaking the samples at different temperatures
(vii)	Infra-red moisture meter	Quick determination of moisture
(viii)	Incubator	Incubating samples at definite temperature
(ix)	Flame photometer	Determining elements

(x)	Centrifuge	Centrifuging samples
(xi)	Refrigerated centrifuge	Centrifuging at low temperatures.
(xii)	pH meter	Determining pH
(xiii)	Colourimeter	Measuring colour intensity
(xiv)	Hot plates	Heating purposes
(xv)	Soxhlet apparatus	Ether extraction
(xvi)	Micro-Kjeldahl assembly	Distillation of nitrogen
(xvii)	Water distillation apparatus	Preparing distilled water
(xviii)	Vacuum oven	Drying at low temperature under vacuum
(xix)	Vacuum pump	Creation of vacuum
(xx)	Toluene disullation apparatus	Moisture determination of silage and molasses
(xxi)	Bomb calorimeter	Determination of gross energy
(xxii)	Digestion pans	Digesting organic matter
(xxiii)	Densitometer	Measuring density
(xxiv)	Mixer	Mixing the samples
(xxv)	BOD-Incubator	For incubating the samples even at lower temperature
(xxvi)	Instrument register	For entering data and time of use of instruments

b. *Glassware*

i. Beakers
ii. Volumetric flasks
iii. Conical flasks
iv. Burette
v. Pippettes
vi. Measuring Cylinders
vii. Round bottom flasks
viii. Funnel
ix. Glass rods

c *Chemicals*

i. Potassium dichromate
ii. Sulphuric acid

3.5 Procedure

— Arrange the instruments/apparatus on a table
— Observe them carefully and note down instructions, if any
— Read the accompanying operational manuals
— Follow the manuals strictly while operating the instruments.
— Seek the help of the teacher in handling instruments and apparatus wherever an operational manual is not provided.
— Check the instruments for its functioning before it is switched off.
— Record the use of the instrument with the date in the instrument register.
— Clean the apparatus after use.
— Cover the instrument in order to protect it from dust and humidity.

3.6 Expected behavioural Outcomes

The pupil will be able to

— identify the various equipment/apparatus/glassware;
— recall the functions of the equipment/apparatus;
— handle the various equipment/apparatus;
— clean glassware properly.

Grade

The teacher should evaluate the pupil for the above abilities.

3.4 Questions

i. Tick (✓) the correct answer:

a. The feed is dried in: incubator/ oven/ muffle furnace/heater.

b. The vacuum pump is used for drying/cooling/incubating/creation of vacuum.

c. A bomb calorimeter is used for detecting colour/gross energy/microminerals.

d. A flame photometer is used for determination of phosphorus/potassium by total ash.

ii. Fill in the blanks:

a. pH is determined by——

b. Trace elements are determined by ————

c. Different instruments for moisture estimation are: —————, ————, ———— and ——

d The nitrogen of the feed sample is determined by ——

e. ———————— is a more sensitive balance for weighing.

iii. Indicate true/false:

a. An incubator is used for drying samples. ( )

b The Soxhlet apparatus is used for determining crude fat. ( )

c. One can play with the instruments. ( )

d. There is no need to check the instruments daily ( )

e. Electrical instruments may cause mechanical injury.

f A cleaning solution should be discarded when it appears green in colour. ( )

ACTIVITY UNIT. 4

Preparation of Various Standard Solutions

4.1 Instructional Objectives

The pupil should be able to:

- define standard solutions,
- recall the terminology used,
- prepare various standard solutions

4.2 Relevant Information

Standard solution

A standard solution is one whose strength or concentration is known.

Normal solution

A normal solution is one that contains one gram equivalent weight of the solute per litre of the solution. The normality of solution is usually designated as N

Gram-equivalent weight

The gram-equivalent weight is the **weight in grams which in its reaction** corresponds to a gram-atom (1.008 g) of hydrogen or of hydroxyl (OH) or half a gram-atom of oxygen

Determination of gram-equivalent weight of acids and alkalis:

Equivalent weight of a substance is that weight equivalent in reacting power to an atom of hydrogen. It is calculated as follows:

$$\text{Equivalent weight of an acid} = \frac{\text{Molecular weight}}{\text{Basicity}}$$

Where basicity of an acid is equal to the number of replaceable hydrogen atoms present in one molecule of the acid.

Hence, equivalent weight of H_2SO_4 **will be 98/2 = 49 and HCl will be** 36.46/1=36.46.

$$\text{Equivalent weight of an alkali} = \frac{\text{Molecular weight}}{\text{Acidity}}$$

Where acidity of an alkali is equal to the number of replaceable hydroxyl groups present in one molecule of the alkali. Hence, equivalent weight of NaOH will be 40/1=40.

Equivalent weight expressed in gram is called gram-equivalent weight.

Determination of gram-equivalent weight of oxidizing agents:

Gram equivalent weight of an oxidizing agent is that weight of the substance which is equivalent to 8 g of available oxygen.

Equivalent weight of $KMnO_4$ in acidic medium is determined as follows.

$2KMnO_4+3H_2SO_4=K_2SO_4+2MnSO_4+3H_2O+5O$

$2(39+55+64) = 316$

$(5\times16) = 80$

316 g of $KMnO_4$ will yield 80 g of oxygen for oxidation. Therefore, 8 g of oxygen will be displaced by 31 6 g of $KMnO_4$ and, hence, it is its ($KMnO_4$) equivalent weight.

Whereas equivalent weight of $KMnO_4$ in alkaline medium is determined as follows :

$2\ KMnO_4+ H_2O= 2MnO_2+2KOH+3O$

In this case, 316 g $KMnO_4$ will yield 48 g of oxygen for oxidation. Therefore, 316/6=52.67 g of $KMnO_4$

So, equivalent weight of $KMnO_4$ in alkaline medium will be 158/3= 52.67

Molar solution

A molar solution is one that contains one mole or one molecular weight in grams of a substance in each litre of the solution, whether the substance is in the form of molecules, ions or any other species It is designated as M.

The molar method of expressing concentration is useful due to the fact that an equal volume of equimolar solution contains an equal number of molecules

Molality

Molality of a solution is the number of moles of the solute per 1000 g of the solvent It is designated as m

Common solutions

The following are a few common solutions which are used in chemical analysis of feed-stuffs Some of these are standard solutions

(a) STANDARD SOLUTIONS
- (i) N/10 H_2SO_4
- (ii) N/10 Na OH
- (iii) N/10 $KMnO_4$
- (iv) N/10 Na_2CO_3
- (v) N/10 $(COOH)_2.2H_2O$

(d) OTHER SOLUTIONS
- (i) 1.25% H_2SO_4
- (ii) 1.25% Na OH
- (iii) 40% NaOH
- (iv) 50% HCl

Calculation of the quantities of the chemicals required for some of the solutions mentioned above :

(a) *N/10 or 0.1 N H_2SO_4 :*

Equivalent weight of H_2SO_4 = 49

Specific gravity = 1.84

So, volume of 49 g H_2SO_4 = 26.6 ml

Conc. H_2SO_4 (reagent grade) is about 94% pure.

Therefore, actual amount of

H_2SO_4 required

for N H_2SO_4 solution = $\frac{100}{94} \times 26.6 = 28.3$ ml

Now, for one litre of N/10 H_2SO_4 solution 2.83 (2.85) ml of concentrated H_2SO_4 is required.

(b) *N/10 NaOH solution L*

Molecular weight of NaOH =40

Acidity (No. of replaceable OH group) = 1

Equivalent weight of NaOH =40

Therefore, 4 g of NaOH when dissolved in 1 litre of water will give N/10 NaOH solution.

(c) *N/10 Na_2CO_3 solution :*

Molecular weight of Na_2CO_3= 106

$Na_2CO_3 + 2HCl = 2\,NaCl + H_2O + CO_2$

So, acidity of Na_2CO_3=2

Equivalent weight of $Na_2CO_3 = \frac{106}{2} = 53$

Therefore, 5.3 g Na_2CO_3 is required for each litre of distilled water to make N/10 Na_2CO_3.

Na_2CO_3 is hygroscopic and therefore, it must be made perfectly anhydrous before it is weighed out.

(d) *N/10 oxalic acid :*

Oxalic acid $(COOH)_2.\ 2H_2O$ has molecular weight 126 and basicity 2.

So, equivalent weight of oxalic acid = 126/2= 63

Therefore, 6.3 g of $(COOH)_2.\ 2H_2O$ is to be dissolved in one litre of distilled water to get N/10 oxalic acid solution.

Note: If anhydrous oxalic acid $(COOH)_2$ is available, then dissolve 4.5 g of the acid in one litre distilled water to get 0.1 N oxalic acid solution.

(e) *1.25% (weight/volume) H_2SO_4 solution :*

To prepare 1.25% (weight/volume) H_2SO_4 solution, 12.5 g of H_2SO_4 is to be added with distilled water to make volume 1000 ml.

or Volume of H_2SO_4 will be

$\frac{12.5}{1.84} \times \frac{100}{.94} = 7.2$ ml

Name, formula, molecular and equivalent weight of some other chemicals

Sr No	*Name*	*Formula*	*Mol. Wt.*	*Eq. wt.*
(i)	Hydrochloric acid	HCl	36 5	36.5
(ii)	Nitric acid	HNO_3	63	63
(iii)	Potassium hydroxide	KOH	56	56
(iv)	Calcium hydroxide	$Ca(OH)_2$	74	37
(v)	Potassium dichromate	$K_2Cr_2O_7$	294	49
(vi)	Sodium thiosulphate	$Na_2S_2O_3\ 5H_2O$	248	248
(vii)	Sodium chloride	NaCl	58.5	58 5
(viii)	Potassium chloride	KCl	74.5	74.5
(ix)	Iodine	I_2	254	127

Preservation of standard solutions

The bottle must be kept tightly stoppered to prevent evaporation of the solvent.

Some solutions must be protected from atmospheric gases for example, sodium hydroxide solution is affected by atmospheric CO_2.

$2\ NaOH + CO_2 = Na_2\ CO_3 + H_2O$

$KMnO_4$ solution should be preserved in coloured (amber) bottles.

The container should be shaken well before withdrawal of a portion of solution to ensure uniform composition of the solution.

Acid-base indicators

Acid-base indicators are those substances, the colour of which in a solution is dependent on the pH of the medium. They are generally complex organic compounds of fairly high molecular weight. In water or other solvents, they behave as weak acids or bases and, thus, participate in equilibrium reactions involving hydrogen ions. The change of colour is due to internal structural rearrangements which is responsible for indicator property.

$$\underset{\text{(Acid)}}{\text{Indicator} + H} \rightarrow H^+ + \text{Indicator}^-$$

$$\underset{\text{(base)}}{\text{Indicator} + OH} \rightarrow OH^- + \text{Indicator}^+$$

Some of the important titrations and choice of indicators are as follows:

Sr. No.	Titrations	Choice of indicator
i.	Strong acid and a strong base	Methyl orange or phenolphthalein
ii.	Weak acid and strong base	Phenolphthalein
iii.	Strong acid and weak base	Methyl red/ methyl orange
iv.	Weak acid and weak base	Methyl orange

4.3 Precautions

- Put on an apron while conducting experiments.
- Use well cleaned, dried glassware.
- Weigh accurately and quickly.
- Never add water to acid.
- Put on a face shield and heavy rubber gloves to protect against splashes during H_2SO_4 handling.
- Add acid always with the help of a burette.
- Clean your working table after the experiment is over.
- Label the solutions with the date of preparation.
- Check the standard solution before use.

4.4 Materials Required

(a) *Reagents*

i. Concentrated sulphuric acid (H_2SO_4 — AR grade)
ii. Sodium hydroxide pellets (NaOH — AR grade)
iii. Oxalic acid $(COOH)_2.2H_2O$ — AR grade)
iv. Sodium carbonate (Na_2CO_3

—AR grade)
v. Concentrated hydrochloric acid (HCl — AR grade)
vi. Potassium permenganate ($KMnO_4$ — AR grade)
vii. Methyl orange indicator
viii. Phenolphthalein indicator
ix. Distilled water

(b) *Apparatus*

i. Balance and weight box
ii. Glazed paper
iii. Volumetric flask (1 litre)
iv. Beakers (50ml, 100ml, 1 litre & 2 litre)
v. Funnel
vi. Glass wool/Filter paper
vii. Pipette
viii. Burette
ix. Heater
x. Glass rods
xi. Wash bottle
xii. Preserving bottles

4.5 Procedure

(a) *Preparation of N/10 H_2SO_4 solution*

— Take 2.85 ml sulphuric acid in a beaker which has already been half filled with distilled water.
— Transfer the contents and the washing into a volumetric flask (1 litre) and make the volume up to the mark.
— Shake well.
— Titrate this solution against 0.1 N Na_2CO_3 (10 ml)using methyl orange as indicator.
— Repeat the titration to get at least three concurrent readings.
— Standardization.

Suppose 10 ml of 0.1 N Na_2CO_3 = 9.5 ml of H_2SO_4

$V_1N_1=V_2N_2$
or, $10 \times 0.1\ N=9.5 \times N_2$
or, $N_2 = 0.10526$

Or

$N_1V_1=N_2V_2$
or, $0.1 \times 1000=0.10526 \times V_2$
or, $V_2 = 950$ ml

To prepare 1 litre N/10 H_2SO_4 the amount of 0.10526 N acid required is $1000 \times 0\ 1 \div 0.10526 =$ 950 ml. Take 950 ml of 0.10526 N acid and dilute to 1 litre. Check it again with N/10 Na_2CO_3 for three times. It must neutralize an equal volume of N/10 Na_2CO_3 solution. Label it as 0.1 N H_2SO_4

(b) *Preparation of N/10 NaOH solution*

— Weigh quickly 4 g of NaOH in a beaker (as it is hygroscopic) and dissolve in distilled water (preferably CO_2-free).
— Transfer the contents and the washings into a volumetric flask (1 litre).
— Cool and then make the volume up to the mark with distilled water.
— Shake well and titrate this solution against N/10 oxalic acid using phenolphthalein indicator.
— Standardize it following the method discussed above in 4 5 a
— Transfer the standard solution

into a bottle for preservation
— Label it as N/10 NaOH solution.

(c) *Preparation of N/10 Na_2CO_3 solution*
— Take about 6-7 g of Na_2CO_3 in a nickel crucible and heat it in a hot air oven at about 100°C for an hour so as to drive out any moisture.
— Weigh exactly 5.3 g dried salt and dissolve it in a little freshly boiled distilled water.
— Transfer it to a one litre measuring flask and make the volume up with distilled water to the mark.
— Shake well and label it as 0.1 N Na_2CO_3 solution.
Note : If weighing is accurate, there is no need to standardize.

(d) *Preparation of N/10 $(COOH)_2$. $2H_2O$ solution*
— Weigh accurately 6.3 g $(COOH)_2$. $2H_2O$ and transfer it to a volumetric flask (1 litre) half filled with distilled water.
— Shake well and make the volume up with distilled water to the mark.
— Label it as N/10 oxalic acid solution.
Note : If weighing is correct, there is no need to standardize.

(e) *Preparation of 1.25% (W/V) H_2SO_4 solution*
— Add 7.2 ml conc. H_2SO_4 (sp. gravity 1.84 and 94% concentration) in a volumetric flask half filled with distilled water.
— Shake well.
— Add the washings and distilled water to make the volume up to the mark.

(f) *Preparation of 1.25% of NaOH solution*
— Add 13.16 g of NaOH (95% NaOH) in one litre distilled water and shake well.

(g) *Preparation of 40% (NaOH) solution*
— Add 400 g NaOH pellets in 1 litre distilled water slowly in a beaker.
— Stir the contents occasionally.
— Place the beaker on a cold water tub, if required.
— Transfer the solution into a bottle after cooling.
— Label it as 40% NaOH solution.

(h) *Preparation of 50% HCl*
— Dilute the HCl (AR Grade) in an equal amount of distilled water.
— Shake the contents well.
— Allow it to cool.
— Transfer the solution into a bottle after cooling.
— Label it as 50% HCl solution.

(i) *Preparation of N/10 $KMnO_4$ solution*
— Dissolve 3.2 g of $KMnO_4$ in one litre of distilled water.
— Boil it for 10-15 minutes and then allow it to stand for a few days.
— Filter through glass wool.
— Take 10 ml of N/10 oxalic acid in a beaker.

— Add dilute sulphuric acid, warm it to about 60-70°C and titrate against $KMnO_4$ from the burette till a light pinkish colour is obtained.
— Take three concord readings

(j) *Standardization*

Suppose, 10 ml 0.1 N oxalic acid = 9.75 ml of $KNnO_4$

$10 \times 0.1\ N = 9.75 \times N_2$

$N_2 = 10 \times 0.1\ N \quad 9\ 75$

To prepare 1000 ml 0.1 N $KMnO_2$ solution, the volume of $KMnO_4$ will be

$$= \frac{1000 \times 9\ 75 \times 10}{10 \times 10} = 975 \text{ ml.}$$

Now take 975 ml of prepared $KMnO_4$ solution and make it 1000 ml by adding distilled water

Note Ordinary or even pure distilled water contains traces of organic matter which reduce the $KMnO_4$ solutions. That is why the solution is boiled and kept for some time before standardization.

In the absence of a sufficient amount of dilute H_2SO_4 or due to the rapid addition of $KMnO_4$ in titration flask brown turbidity (manganous oxide) may appear.

4.6 Calculations

Refer to item 4.2

4.7 Expected Behavioural Outcomes

The pupil will be able to:

Grade

— handle different reagents and glassware properly
— prepare various standard solutions.
— preserve the standard solutions.

The teacher should evaluate the pupil for the above abilities.

4.8 Questions

(i) Why is water not added in acid?
(ii) What is the special care taken during the handling of H_2SO_4?
(iii) $KMnO_4$ is titrated against $(COOH)_2$ in the presence of H_2SO_4 using no indicator. Why?
(iv) Why is it essential to wear an apron while working in a laboratory?
(v) What is equivalent weight and how does it differ from molecular weight?
(vi) Tick the correct answer.
  (a) The equivalent weight of NaOH is 40/60/20
  (b) The equivalent weight of H_2SO_4 is 98/49/28 6
  (c) The indicator used in strong acid-alkali titration is bromocresol green / methyl orange / methyl red / phenolphthalein
  (d) $KMnO_4$ is an oxidizing/reducing agent
  (e) Gram equivalent weight of $KMnO_4$ in acid medium is 52.67/31.6/158 g

ACTIVITY UNIT · 5

Determination of Moisture/Dry Matter

5.1 Instructional Objectives

The pupil should be able to :

— recall the importance of dry matter estimation;

— find out dry matter and moisture content in the feed sample.

5.2 Relevant Information

Moisture

Moisture or water is recorded as the loss in weight of a sample as a result of oven-drying it, to a constant weight at atmospheric pressure and at a temperature just above the boiling point (100°C) of water The significance of the water content of feeds depends on the kind of feed and the amount of water

Dry matter

The sample left after complete evaporation of moisture is called dry matter. All the nutrients of feed are expressed on dry matter basis Again, the requirements are also specified on dry matter basis. Dry matter is, therefore, a common denominator for the comparision of foods in terms of nutritive value.

Role of moisture during storage of feeds

The problem of feed storage is complicated by high moisture content. Feeds containing more than 14 per cent moisture cannot be stored in bulk The high moisture is likely to result in mould growth, and spontaneous combustion may also take place.

Role of water relative to feed cost

Calculating the relative cost of feed per unit of nutritional value frequently involves the consideration of water, since water is not a nutrient in the usual sense Sometimes, grains or grain byproducts are sold by increasing the moisture content and that increases the price per unit dry matter

Role of feed water

When excessively dry feeds are ground for feeding, it increases dustiness. Animals universally dislike dusty feeds The dustiness can be corrected by adding small quantities of water or molasses On the other hand, forcing animals to consume too much

water may limit their intake of other nutrients because of the limited capacity of the digestive system. Feeding standards do not include the water requirement for animals

Determination of water in samples and problems associated with it :

For many biological materials such as silage, molasses and excreted feed residues (faeces), oven drying results in a loss of volatile fatty acids, nitrogenous bases, and some sugars that decompose at temperatures above 70°C. Such substances will obviously be counted as water. In this case, moisture is determined by distillation, using toluene which is immiscible with water or by drying at lower temperatures in a vaccum. However, the latter method is not followed because the vacuum ovens are of relatively small capacity which may be a problem if much routine work is involved. Oven drying is the common method of moisture estimation in the proximate system of analysis

5.3 Precautions

- Ensure the correct temperature of the oven
- Weigh quickly and accurately.
- Cool the sample after oven drying in a desiccator.
- Determine the moisture content immediately after the receipt of the sample.
- Avoid exposure of the sample to atmospheric conditions.
- Analyse the sample in duplicate

5.4 Materials Required

(i) Balance
(ii) Moisture cup or moisture box
(iii) Hot air oven
(iv) Desiccator
(v) Weight box
(vi) Metal tongs

5.5 Procedure

- Dry the moisture cup in an oven at 100°C temperature, cool it in a desiccator and record its weight.
- Take about 10 g of the material in the moisture cup and weigh out to calculate the actual amount of material taken
- Dry it in a hot air oven at 100°C for 24 hours.
- Remove the moisture cup from the oven and cool it in a desiccator.
- Repeat the process of heating and cooling till a constant weight is achieved and record the constant weight of the moisture cup with the sample

5.6 Observations

The pupil should record the following

- Weight of empty moisture cup = ... g (W_1)
- Weight of moisture cup + sample = ... g (W_2)
- Weight of sample = W_2-W_1. g = (W_3)
- Weight of moisture cup+dried sample = ... g (W_4)
- Weight of dried

sample = W_4-W_1 g (W_5)

— Weight loss after drying = W_3- W_5 g

5.7 Calculation

The pupil should calculate the % of moisture and dry matter in the given sample as per the following formula:

$$\text{Moisture, \%} = (W_2\text{-}W_1)\text{—}(W_4\text{-}W_1)/W_3 \times 100$$

$$= W_3\text{-}W_5/W_3 \times 100$$

$$\text{Dry matter, \%} = W_4\text{-}W_1/W_2\text{-}W_1 \times 100$$

$$= W_5/W_3 \times 100$$

or

$$\text{Dry matter \%} = 100 - \%\ \text{moisture}$$

5.8 Expected Behavioural Outcomes

Grade

The pupil will be able to :

— handle the equipment correctly;

— determine the sample size for dry matter estimation;

— determine the moisture/dry matter content of feed-stuffs;

— classify feed-stuffs as succulent or dry.

The teacher should evaluate the pupil for the above abilities.

5.9 Questions

(i) Explain the need of moisture estimation.

(ii) What are the ill effects of excess moisture content in feed-stuffs?

(iii) Mention the permissible limit of moisture content of feeds for storage

(iv) Why is moisture estimation not always simple?

(v) Name the various methods of moisture estimation.

ACTIVITY UNIT . 6

Determination of Ether Extract/Crude Fat

6.1 Instructional Objectives

The pupil should be able to :

— recall the importance of fat in the diet;

— recall the terms "crude fat" and "true fat";

— find out the crude fat content in the given feed sample.

6.2 Relevant Information

Ether extract/crude fat

This represents a fraction of feed generally consisting of substances such as glycerides of fatty acids, free fatty acids, sterols, phospholipids, chlorophyll, alkali substances, volatile oils, waxes, resins, fat soluble vitamins, etc. The ether extract content of the sample is estimated by treating it with a solvent like petroleum ether, benzene, diethyl ether, etc. Ether is continuously volatilized, condensed and allowed to pass through the sample at 55 to 60°C temperature, at which the solvent evaporates. The ether extracts or crude fat is designated as EE.

Nutritional significance of ether extract

Ether extract or crude fat is a source of the essential fatty acids besides providing energy. It is also a source of fat soluble vitamins like A, D, E and K.

The crude fat component of feeds is not stable

This feature makes the storage of high-fat feeds a problem. Rancid feeds are objectionable, because they have usually lost appreciable quantities of such nutrients as vitamins and essential fatty acids. Some undesirable substances such as amines are formed. Sometimes, actual combustion of feeds takes place due to rancidity.

Crude fat vs. true fat

True fats are defined as the esters formed by the union of glycerol and

three moles of fatty acids, while crude fat includes all those substances present in feed which are ether soluble, besides true fat as discussed earlier. The true fat is highly digestible, while "false" fats like chlorophyll, resin, waxes, etc are not digestible and do not provide any energy As a result, they over-estimate the energy content of the feed stuffs.

6.3 Precautions

- Ensure that the top of the thimble is above the siphon tube while placing the thimble containing the sample in the Soxhlet's flask.
- Put a cotton swab on the mouth of the condenser to avoid loss of ether vapour.
- Preserve the extracted sample for the estimation of crude fibre.

6.4 Materials Required

(a) *Reagent*
Petroleum ether or any other fat solvent

(b) *Apparatus*
(i) Soxhlet's apparatus
(ii) Thimble with cotton swab
(iii) Hot plate
(iv) Balance and weight box
(v) Desiccator
(vi) Oven

6.5 Procedure

- Weigh out a small quantity of the sample (usually less than 5 g) into a weighed extraction thimble (completely dried) having porosity permitting rapid passage of ether
- Remove water from the sample by placing it overnight at 105°C in a drying oven. Cool it in a desiccator and weigh
- Place the thimble in the Soxhlet's apparatus in a upright position so that the condensed ether may drop on it.
- Check the flasks under the Soxhlet to see if they are 3/4 full of petroleum ether Make sure that water is running through all the condensers The extraction period may vary from 4 hours at a condensation rate of 5-6 drops per second to 16 hours at 2-3 drops per second
- Take out the thimble. Keep it at room temperature for evaporation of ether and then keep overnight in the oven at 100-105°C
- Remove the thimble from the hot air oven, cool it in a desiccator and weigh.

6.6 Observations

The pupil should take and record the following

- Weight of dried thimble =—g
- Weight of thimble + sample dried =—g
- Weight of dried sample =—g
- Weight of thimble + sample after extraction and drying =—g
- Loss in weight of thimble/ weight of crude fat =—g

6.7 Calculations

The pupil should calculate the % ether extract as per the formula given below .

Weight of sample = Weight of thimble + sample — Weight of thimble.

Weight of fat = Weight of thimble + sample — Weight of thimble + sample after extraction

% ether extract = Weight of fat/Original Weight of Sample × 100

6.8 Expected Behavioural Outcomes

The pupil will be able to :

	Grade
— handle the equipment correctly,	
— recall the importance of ether extract determination;	
— determine the ether extract/crude fat content of feed-stuffs.	

The teacher should evaluate the pupil for the above abilities.

6.9 Questions

(i) Explain the need of estimating fat or ether extract in feeds.

(ii) Fill in the blanks :

(a) Ether extract consists of ... .. and ....

(b) Fat Solvents are... .. .., ..., ...

(c) Fat is the source of....., ... and ....

(iii) Why is the thimble cooled in a desiccator?

(iv) Why is a cotton swab put on the mouth of the condenser?

ACTIVITY UNIT : 7

Determination of Crude Fibre

7.1 Instructional Objectives

The pupil should be able to :

— recall the importance of crude fibre in animal diet;

— find out the crude fibre content in the given sample.

7.2 Relevant Information

Crude fibre : Crude fibre (CF) includes those materials in feeds which are mostly undigested by monogastric animals (like pigs, poultry, monkey, men, etc.). It consists of cellulose, and variable proportions of hemicellulose and lignin along with some minerals. The estimation of crude fibre is based on treating the moisture and fat-free sample with dilute (1.25%) acid and alkali. It is designated as CF.

Nutritional importance of CF :

It is the portion of total carbohydrate of a feed which is not digested by the secretions/enzymes produced in the animal body but is digested through fermentation by microbial enzymes in the three chambers of the stomach viz., rumen, calcum and colon of the animals Digestibility is higher in ruminants than in non-ruminants The earlier supposition was that it represented an indigestible portion of the feed. But it is recognized now that in large number of cases, particularly in ruminants the CF is as highly digested as the soluble carbohydrates.

The largest portion of CF is cellulose, and the microorganisms of the rumen are able to break down cellulose for their own needed energy and in the process they produce acetic, butyric and propionic acids, which are absorbed from the rumen and supply energy to the host animal. Other reasons for considering CF are that it is correlated with the bulkiness of a feed and butter fat content of milk

Physical role of CF

CF gives bulk and has a laxative effect. The normal peristaltic movements of the intestinal tract are also dependent on CF.

7.3 Precautions

— Keep the volume constant during boiling.
— Avoid foaming by heat adjustment or by adding a few drops of iso-amyl alcohol, if necessary.
— Ensure that the muslin cloth used has 18 threads to a centimetre.

7.4 Materials Required

(a) *Reagents*
(i) 1.25% (w/v) H_2SO_4 solution
(ii) 1.25% NaOH solution.

(b) *Apparatus*
(i) Tall spoutless beaker (1 litre capacity)
(ii) Round bottom condenser
(iii) Measuring cylinder
(iv) Sintered glass crucible
(v) Balance
(vi) Muslin cloth
(vii) Vacuum pump
(viii) Hot plate
(ix) Wash bottle
(x) Muffle furnace

7.5 Procedure

— Weigh about 2 g moisture and fat-free sample and transfer it into the spoutless 1 litre beaker
— Add 200 ml of 1.25% sulphuric acid.
— Place it on heat and allow to reflux for 30 minutes.
— Shake the contents after every five minutes.
— After boiling for 30 minutes, remove the beaker from the hot plate and filter through a muslin cloth, using suction. Wash the residue with hot water till free from acid.
— Transfer the material to the same beaker and add 200 ml of 1.25% NaOH solution.
— Again, reflux the contents for 30 minutes, timed from the onset of boiling.
— Filter again through the muslin cloth and wash the residue with hot water till free from alkali.
— Transfer the residue into a crucible and filter the excess water with the help of a vacuum or suction pump.
— Place the crucible in a hot air oven, allow to dry it to a constant weight at 80-100°C and record its weight.
— Ignite the residue in a muffle furnace at 550°-600°C for 2 or 3 hours, cool and weigh again. The loss of weight due to ignition is the weight of crude fibre.

7.6 Observations

The pupil should record the following
— Weight of fat-free and moisture-free sample = ——g
— Weight of crucible+fibre before ashing = ——g

— Weight of crucible+ash = ——g
— Loss of weight/weight of CF = ——g

7.7 Calculations

The pupil should calculate the percentage of crude fibre as per the following formula ·

$$\text{Crude fibre \%} = \frac{\text{Weight of crude fibre}}{\text{Original weight of sample}} \times 100$$

7.8 Expected Behavioural Outcomes

The pupil will be able to ·	Grade
— recall the importance of crude fibre in animal feed;	
— handle the equipment correctly,	
— determine the crude fibre content of feed-stuffs;	
— classify the feed-stuffs as roughage and concentrate	

The teacher should evaluate the pupil for the above abilities.

7.9 Questions

(i) Why is a fat-free sample taken for CF estimation?
(ii) Why is the volume kept constant during boiling?
(iii) Why does frothing occur and how can it be avoided?
(iv) Fill in the blanks :
  (a) The strength of acid and alkali used for digestion is ....., ... respectively.
  (b) The CF consists of ....., ... and ... ...
  (c) Crude fibre estimation is carried out for ..... sample.

ACTIVITY UNIT : 8

Estimation of Nitrogen-Free Extract

8.1 Instructional Objectives

The pupil should be able to :

— recall the importance of nitrogen free extract, as a component of total carbohydrate;

— find out nitrogen free extract content in the given sample;

— explain the nature and make up of the fraction designated as nitrogen free extract.

8.2 Relevant Information

Nitrogen free extract

Nitrogen free extract is a mixture of all the starches and sugars of the sample, plus some hemicellulose and much of the lignin. In actual fact, nitrogen free extract is the difference between the original weight of the sample and the sum of the weights' of its water, ether extract, crude protein, crude fibre, and ash, as determined by their appropriate analyses. It is designated as NFE.

Nutritional significance of NFE

NFE is a practically useful index of the non-cellulose portion of feed carbohydrates and is the primary source of easily available energy to the animals. Its digestibility is variable but higher than the protein, fat and crude fibre of the same feed. This fraction makes 40 per cent of the dry weight of forage feeds, and 70 per cent of the basal feeds. Protein supplements may have as little NFE as the forages.

8.3 Precautions

— Analyze water, crude Protein (CP), crude Fibre (CF), Ether Extract (EE) and ash accurately.

8.4 Materials Required

— Data from Activity Units 5, 6, 7, 9, 10.

8.5 Procedure

— Collect data for water, crude protein, crude fibre, ether extract and ash of the given sample from

the Activity Units listed above.

— Deduct the sum of water, crude protein, crude fats, ether extract and ash contents of the original sample from 100

8.6 Observations

The pupil should collect the data from Activity Units 5, 6 7, 9, 10 and record the following :

Moisture content = —— %
Crude protein content = —— %
Ether extract content = ——%
Crude fibre content = ——%
Ash content = ——%

8.7 Calculations

The pupil should calculate as per formula given below :

Nitrogen Free Extract, % =
100-(% moisture +%CP +% EE +% CF + % Ash)

8.8 Expected Behavioural Outcomes

The pupil will be able to :

— recall the nutritional significance of NFE;

— calculate nitrogen free extract content of feed-stuffs.

The teacher should evaluate the pupil for the above abilities.

Grad

8.9 Questions

(i) How can the NFE content of a given sample be estimated accurately?

(ii) Explain the limitations of NFE estimation.

(iii) True or false :

(a) Basal feed contains a higher percentage of NFE than protein supplement.

(b) The estimation of NFE content of a feed is realistic.

(c) NFE consists of the protein and carbohydrate portion of the feed.

(d) Forage feeds contain less NFE than basal feeds.

ACTIVITY UNIT : 9

Determination of Crude Protein

.1 Instrdctional Objectives

The pupil should be able to .

— differentiate between the terms 'crude protein' and 'true protein';
— find out the crude protein content in the given sample;
— classify the feed-stuffs based on the protein content.

2 Relevant Information

Crude protein

Crude protein includes true protein plus non-protein nitrogen multiplied by 6.25. The nitrogen present in the protein is called true protein nitrogen while the nitrogen from sources other than protein, e.g. ammonia, urea, uric acid, amino acids, etc. are called non-protein nitrogen. Crude protein is usually designated as CP.

Proteins contain on an average 16 per cent nitrogen. Therefore, one per cent nitrogen is equivalent to 100/16 =6.25 per cent protein. However, in some cases, crude protein is determined by multiplying the nitrogen by some other factor, depending on the percentage of nitrogen that is known to be in the protein of that particular material, such as milk and wheat.

Classification of feed-stuffs based on protein content

This classification of feed-stuffs is essentially based on the protein content. Basal feeds are low protein feeds. Protein supplements are high protein feeds. Legumes contain more protein than other forages like straw. Therefore, by estimating the protein content of a feed we can get an idea of the class of feed to which it must belong, even though we do not know its other characteristics

Protein as a source of energy and as an index of total amino acids

Protein is an important component of feed-stuffs for several reasons. The protein component of the diet is usually highly digested. Forages that are high in protein are almost sure to be lower in crude fibre. Therefore, such a product is more digestible than one that has a high fibre content and a lower protein content. However,

as a source of energy, protein is subject to a loss of about 20 per cent. Thus, when the energy content of the diet is to be enhanced, protein is not the preferred source. The quality of protein depends upon the essential amino acid make up and is of minor importance in the rations of dairy animals except for very young animals.

Different methods of protein estimation : The different methods of protein estimation are the macro kjeldahl, micro kjeldahl, biuret, electrophoretic, etc. In the proximate system of feed analysis, crude protein is estimated by the micro kjeldahl method.

Micro kheldahl Method : When organic nitrogen is digested with concentrated sulphuric acid (H_2SO_4) in the presence of a digestion mixture or catalyst (selenium oxide or potassium sulphate and copper sulphate) it is converted into ammonium sulphate ($(NH_4)_2$ SO_4). Ammonia (NH_3) liberated by making the solution alkaline, is distilled into a known volume of standard acid, which is then back titrated. The protein content, therefore, is obtained by multiplying the nitrogen value with 6.25.

Organic Nitrogen + H_2SO_4 = $(NH_4)_2SO_4$

$(NH_4)_2$ SO_4 + 2 NaOH = 2 NH_3 + Na_2SO_4 + $2H_2O$

2 NH_3 + H_2SO_4 = $(NH_4)_2$ SO_4

Digestion mixture : This is a mixture of potassium sulphate (K_2SO_4) and copper sulphate ($CuSO_4$) in the ratio of 9:1. It acts as a catalyst during digestion of the sample. K_2SO_4 is added to raise the boiling point for efficient oxidation of material, while $CuSO_4$ is added to speed up the reaction.

9.3 Precautions

— Avoid bumping during digestion by adding glass beads, if necessary.
— Avoid incomplete digestion.
— Set the conical flask containing N/100 H_2 SO_4 before adding 40% NaOH.
— Avoid loss of ammonia by dipping the tip of the condenser in acid (N/100 H_2SO_4).

9.4 Materials Required

(a) *Reagents*
- (i) Digestion mixture (K_2SO_4 and $CuSO_4$ in the ratio of 9:1)
- (ii) Nitrogen free concentrated H_2SO_4
- (iii) 40% NaOH solution
- (iv) N/100 NaOH solution
- (v) N/100 H_2SO_4 solution
- (vi) Methyl red indicator (0.1 g of the indicator dissolved in 60 ml of alcohol and water added to make a volume of 100 ml)

(b) *Apparatus*
- (i) Kjeldahl's flask
- (ii) Balance
- (iii) Digestion bench
- (iv) Micro Kjeldahl distillation assembly

(v) Volumetric flask
(vi) Burette
(vii) Pipette
(viii) Beaker/Conical flask(s)

9.5 Procedure

(a) *Digestion*
- Take 0.5 to 2.0 g of representative sample and transfer it to the Kjeldahl flask.
- Add 10 to 20 ml conc. H_2SO_4.
- Add 2 to 5 g digestion mixture.
- Place the flask on the digestion bench and heat till the solution becomes clear blue.
- Remove the flask and cool it.

(b) *Distillation*
- Add 5 to 10 ml distilled water and transfer the solution to a 100 ml volumetric flask with repeated washings till the volume is reached.
- Take 10 ml aliquot and transfer it into the micro Kjeldahl assembly.
- Take 10 ml of N/100 H_2SO_4 in a conical flask with the help of a pipette.
- Add 2 to 3 drops of methyl red indicator
- Set this conical flask under the condenser.
- Add 15 to 20 ml of 40% NaOH solution to the distillation flask and put stopper immediately.
- Allow distillation for 10 to 15 minutes.

(c) *Titration*
- Remove the conical flask after washing the tip of the condenser with distilled water.
- Back titrate the flask contents with standard alkali (N/100 NaOH) till the end point is reached (red to pink).
- Record the volume of alkali used in titration to calculate the volume of standard H_2SO_4 (N/100) used for ammonia absorption.

9.6 Observations

The pupil should record the following:
- Weight of the sample taken for digestion = — g
- Volume made of the digested sample = — ml
- Aliquot taken = — ml
- Initial reading of N/100 NaOH in burette = — ml
- Final reading of N/100 NaOH in burette = — ml
- Actual amount of N/100 NaOH used for titration. = — ml
- Actual amount of N/100 H_2SO_4 used = — ml

9.7 Calculation

The pupil should calculate the percentage of crude protein by the following formula :

1 ml N/100 H_2SO_4=0.00014 g nitrogen

$$\% \text{ crude protein} = V \times 0.00014 \times D \times 100 \times 6.25/W \times A$$

Where,

V=Volume in ml of N/100 H_2SO_4 used

D=Dillution factor (volume in ml made in volumetric flask)

W=Weight (g) of sample

A=Aliquot taken (ml)

Since average nitrogen content of most proteins is 16%, 1 g nitrogen =100/16 = 6.25 g protein

9.8 Expected Behavioural Outcomes

The pupil will be able to :

— handle the instruments and reagents;

— estimate the protein content of a given sample;

— recognize protein supplements.

Grade

The teacher should evaluate the pupil for the above abilities.

9.9 Questions

(i) Tick mark (√) the correct answers :

(a) The flask for digestion is called conical flask/Kjeldahl flask/volumetric flask

(b) Digestion mixture contains K_2SO_4 and $CuSO_4$ in the ratio of 1:9/9:2/9:1.

(c) The indicator used for titration is methyl red/methyl orange/phenolphthalein.

(d) On an average, protein contains 16%/17%/19% nitrogen.

(e) The ammonia liberated is absorbed in N/100 NaOH/ N/100 H_2SO_4/Conc. H_2SO_4.

(ii) Fill in the blanks :

(a) Digestion mixture contains... and.. .....

(b) Sources of non-protein nitrogen are ....., ..., ... and .....

(c) The end point of titration is a change of colour from ..... to . ...

(d) Protein is a source of . ..... and . .....

(iii) Answer the following :

(a) Why is digestion mixture added?

(b) Why is the micro-Kjeldahl method followed for CP estimation?

(c) Why does bumping occur during digestion?

(d) Why are glass beads added to prevent bumping?

ACTIVITY UNIT : 10

Determination of Total and Acid Insoluble Ash

10.1 Instructional Objectives

The pupil should be able to:

- recall the importance of minerals in feed-stuffs;
- find out the total ash (mineral matter and acid insoluble ash) in the given sample;
- explain acid insoluble ash as an index of feed evaluation.

10.2 Relevant Information

Ash (mineral matter)

Ash is the inorganic residue left after complete ignition of the feed at about 600°C in a muffle furnace. The figure for crude ash does not seem to have any direct nutritional use, but it is to be determined in proximate analysis to estimate the nitrogen-free extract and total organic matter in the given sample

Acid insoluble ash

When the ash is digested into dilute hydrochloric acid (1:1), inorganic salts get dissolved in it and the remaining portion is called acid insoluble ash. This is mainly silica and has no nutritional value.

Acid insoluble ash as an index of feed quality evaluation

The acid insoluble ash content of feed samples depends upon the incidental or accidental contamination of sand, clay with the feeds/ fodders. Digestibility of feed samples are inversely proportional to the content of acid insoluble ash in the compound feed. The maximum permissible limit of acid insoluble ash is 3 per cent.

10.3 Precautions

- Do not open the muffle furnace unless the temperature comes down to below 100°C.
- Ensure that the temperature does not exceed 600°C in the muffle furnace.
- Cool the crucible in the desiccator without losing any time.
- Weigh quickly and accurately.

10.4 Materials Required

(a) *Reagents*
- (i) Hydrochloric acid (1:1 in distilled water)

(b) *Apparatus*
- (i) Balance and weight box
- (ii) Silica crucible
- (iii) Pair of long tongs
- (iv) Muffle furnace
- (v) Desiccator
- (vi) Water bath
- (vii) Whatman filter paper No. 42 or its equivalent (No. 40, 41, 44, etc.)
- (viii) Funnel
- (ix) Volumetric flask
- (x) Watch glass
- (xi) Pipette
- (xii) Oven
- (xiii) Burner

10.5 Procedure

(a) *Determination of total ash*

— Dry the crucible in an oven. Cool it in the desiccator and record its weight.

— Weigh about 5 g of oven dried sample in the weighed crucible.

— Ignite the sample on a burner or an electric heater, till the smoke is removed.

— Transfer the crucible to a muffle furnace with the help of a pair of long tongs. Keep it at 600°C temperature (at this temperature all organic matter will be burnt, leaving white ash) for two hours.

— Remove the crucible from the furnace, cool in a desiccator and weigh. The previously recorded empty crucible weight is now subtracted and the weight of ash is, thus, determined.

Note: Preserve this ash for extraction of the acid soluble minerals and, thus, for estimation of the acid insoluble ash.

(b) *Determination of acid insoluble ash*

— Add 20 ml dilute hydrochloric acid (1:1) in the crucible containing ash.

— Cover the crucible with a watch glass and digest for 20 to 30 minutes on a water bath.

— Remove the watch glass and rinse with water.

— Filter through Whatman filter paper No. 42, and wash the residue with 5 per cent hydrochloric acid solution.

— Collect the filtrate in a volumetric flask (100 ml) and repeat the process till the volume is made; preserve the filtrate for estimation of different inorganic ingredients.

— Transfer the filter paper along with the residue to the same crucible and ignite it.

— Cool it in a desiccator and determine its weight. The increase in the weight of the crucible gives the weight of acid insoluble ash.

10.6 Observations

The pupil should record the following:

(a) Weight of silica crucible =———g

Weight of silica crucible+sample = ——————g
Weight of sample = ——————g
Weight of silica crucible+ash = ——————g
Weight of ash = ——————g
Weight of silica crucible + acid insoluble ash = ——————g
Weight of acid insoluble ash = ——————g

10.7 Calculations

The pupil should calculate the % ash and acid insoluble ash as per the following formula:

% Ash or mineral matter = Weight of ash Weight of original sample x 100

% Acid insoluble ash = Weight of insoluble ash Weight of Original sample x100

10.8 Expected Behavioural Outcomes

The pupil will be able to:

— handle the equipment correctly,
— determine the total ash and acid insoluble ash;
— detect the adulteration of acid insoluble ash (silica), if any.

The teacher should evaluate the pupil for the above abilities.

Grade

10.9 Questions

(i) What is the significance of ash estimation of in proximate system of anlysis?
(ii) Why is acid insoluble ash estimated?
(iii) What is the permissible limit et up by ISI for acid insoluble ash in the compound feed?
(iv) Total ash of lucerne is 13 per cent on dry matter basis Express it on fresh basis, if the dry matter content of lucerne is 20 per cent.
(v) Why should muffle furnace not be opened at a higher temperature?
(vi) During digestion of ash, the crucible is covered with a watch glass; Why?
(vii) Calculate the ash content on dry matter basis from the following data:

(a) Weight of crucible =22.480 g
(b) Weight of crucible+sample (fresh) =24 500 g
(c) Weight of crucible+ash =23.580 g
(d) Dry matter content of the sample =95%

ACTIVITY UNIT : 11

Detection of Common Feed Adulterants

11.1 Instructional Objectives

The pupil should be able to :

- recall common feed adulterants;
- identify the various types of common feed adulterants;
- recall the harmful effects of common feed adulterants;
- detect the various feed adulterants.

11.2 Relevant Information

Feed adulterants

Feed adulterants are generally mixed along with the concentrate mixture, specially when it is in mash or pellet form. Individual ingredients are also sometimes found adulterated with various types of adulterants which are not only poor in nutritional value but are also harmful to the animals. In green fodders, dry fodders or silages, this problem is not significant. The main aim of adulteration of feed ingredients for the concentrate mixture is to make more profits for the supplier. Therefore, one has to be cautious about the adulterants while purchasing the feed-stuffs.

A common concentrate mixture may contain maize, barley and oats grains, wheat bran, rice bran, rice polish, oilseed cakes like groundnut cake, linseed cake, til cake, mustard cake. *Dal chunies* are also used where available.

Agro industrial by-products are also used now-a-days in the formulation of concentrate mixtures, in small proportions, to economize in the cost of feeding. The common by-products are, molasses, salseed-meal, guar-meal, brewer's grain (residue of barley grain after extraction of its starch by the wine industry), mango seed kernel, maize gluten, tapioca wastes, oat kernels, boiled *Cassia tora* seeds, babool pods and tamarind seed powder. In addition to these, some marine wastes and products, like prawn shell and head wastes, lobster

waste, fish wastes, frog packaging wastes, shark liver residue, squilla (caught in trawl nets along with prawn and fish) are used as ingredients of concentrate mixtures. Meat processing factory wastes like tankage, meat scraps, blood-meal and feather-meal, are useful ingredients of concentrate mixture in the rations of pigs and poultry.

Why is feed adulterated?

There are 3 main reasons for feed adulteration :

(i) To increase weight
(ii) To increase its nitrogen content
(iii) To increase bulk

(i) *Weight :* There are two important adulterants which are used for increasing the weight of concentrates. One is sand which is freely available and generally mixed with ingredients like wheat bran, rice bran, *chunies,* oilcakes and also in concentrate mixtures made in mash form. Sometimes, pelleted feed is also found adulterated with sand. The addition of sand can easily be detected by the acid insoluble ash contents of the feed. The second main adulterant is water or moisture. The concentrate mixtures or the ingredients may be adulterated with water to increase the weight. Besides adulteration, this creates problems in the storage of feeds and mixtures. Feed with a high moisture content is spoiled by fungi/bacteria, making it unpalatable and, sometimes, also toxic. The easy way to detect the addition of moisture is determination of dry matter content of feed stuffs in the laboratory.

(ii) *Nitrogen content :* Generally, urea or some other non-protein nitrogen compound is added to a concentrate mixture to increase its nitrogen or crude protein content. This may be done by spraying urea or other non-protein nitrogen compound on the ingredient itself or on the concentrate mixture in mash form or before pelleting. This type of adulteration can be detected by determining the non-protein nitrogen content of the feed because addition of urea or any other non-protein nitrogen compound increases the total non-protein nitrogen content of the feed.

(iii) *Bulk :* Several adulterants are used to increase the bulk of the concentrate mixture of feed ingredients. The most common of them are :

(a) Rice husk
(b) Sawdust
(c) Groundnut shells
(d) Brick powder
(e) Small pieces of stones

(a) *Rice husk :* This adulterant is generally found in rice bran and rice polish. Rice husk, which is a waste from rice mills, is finely powdered and mixed in the feeds. This adulterant

can be detected in the laboratory by determining the crude protein and crude fibre contents of the feed. Because rice husk increases the fibre content and decreases the protein level of the feed, the nutritive value is drastically reduced by adulteration.

(b) *Sawdust:* This is added to the feeds that are available in the form of mash and in rice bran, wheat bran or in compound feeds before pelleting. Sawdust can be detected by determination of the crude fibre and lignin content of the feed. Since both of these constituents (crude fibre and lignin) are increased with the addition of sawdust, the adulteration decreases the nutritive value of the feed.

(c) *Groundnut shells:* These are mixed with groundnut cake to increase its bulk. In a groundnut sheller, groundnut shells are a waste product, having no economic value. They can be detected by determining the crude fibre content of the feed since the addition of groundnut shells increases the crude fibre content of the groundnut cake.

(d) *Brick powder:* This is added in the mineral mixtures to increase the bulk as well as weight of the mineral mixture. It can be detected by determining the acid insoluble ash in the feed. Added brick powder will increase its acid insoluble content.

(e) *Small pieces of stones:* Sometimes, stone pieces are found mixed with grains. These can be detected by determining the acid insoluble ash which increases after its addition.

11.3 Precautions

— Examine the feed ingredients individually for adulteration before preparing the concentrate mixture.
— Purchase concentrate feed ingredients from a reliable source.
— The concentrate mixture of feed ingredients should occasionally, be analyzed in a laboratory to check their quality and nutritive value.

11.4 Materials Required

(i) Feed ingredients
  (a) Grains like maize, barley and oats
  (b) By-products of grains
    Rice bran
    Wheat bran
    Rice polish
    Dal chunies
  (c) Oilseed cakes :
    Groundnut cake
    Mustard cake
    Linseed cake
    Til cake
    Salseed cake
(ii) Pelleted feed
(iii) Feed in mash form
(iv) Common adulterants :
  (a) Powdered rice husk
  (b) Sawdust
  (c) Powdered groundnut shells
  (d) Brick powder

(e) Small pieces of stones

(iv) Beaker, 500 ml.

11.5 Procedure

Do the following test for detecting adulteration with rice husk, sawdust, sand and brick powder.

Sedimentation test

— Take a beaker of 500 ml capacity.
— Fill it with water upto 2/3 of its capacity.
— Soak about 25 g of feed or any single ingredient in powder form.
— Keep it for 2-3 hours.
— If sand or brick powder is present, it will settle down at the bottom whereas husk and sawdust will float.
— Repeat the same for other adulterants.

11.6 Observations

The puupil should record the presence of the following in the feed or any single ingredient :

Name of the feed	*Husk*	*Sawdust*	*Sand*
i			
ii			
iii			
iv.			

11.7 Expected Behavioural Outcomes

The pupil will be able to :

— recall the various types of common feed adulterants;
— recall the harmful effects of various types of feed adulterants;
— detect the various feed adulterants.

The teacher should evaluate the pupil for the above abilities.

11.8 Questions

(i) Tick mark (✓) the correct answer :

(a) A common feed adulterant is: rice husk/groundnut cake/ mustard cake.

(b) Adulteration with sand can be detected by : sedimentation test/iodine test.

(c) Rice husk is generally added to : linseed cake/wheat bran/ rice bran.

(d) Brick powder is generally added to :

concentrate mixture/mineral mixture.

(ii) Fill in the blanks :

(a) Feed adulterants are added to increase ..... in the concentrate mixture.

(b) The presence of sawdust can be detected by .....

(c) ..... is generally added to increase the nitrogen in the feed.

(iii) What are the possible harmful effects of various feed adulterants on the health of animals?

ACTIVITY UNIT : 12

Physical Evaluation of Grains and other Feed Components of Dairy Rations

12.1 Instructional Objectives

The pupil should be able to:

- recall the significance of physical evaluation of grains or rations.
- examine the suitability of various feeds and fodders required for the preparation of dairy rations;
- rank various feed-stuffs on the basis of physical appearance.

12.2 Relevant Information

Importance of physical evaluation

For proper feeding of livestock, good quality roughages and concentrate mixtures are essential. Green fodder, dry fodder, hay and silage make the bulk of the rations. They usually meet about 80 per cent of the nutrient requirements of animals. In view of this it is necessary to understand the importance of roughages in the rations of dairy animals and this is possible through physical evaluation of the quality of green fodder, dry fodder or silage. The concentrate mixtures are an equally important component of dairy rations, specially for high-producing animals. The concentrate mixtures are prepared out of various ingredients which include cereal grains, their by-products, oil-seed cakes, feeds of animal origin and mineral supplements. The quality of grain or feed components can be evaluated by two methods i.e. physical and chemical. The physical method is easy and quick, consumes less time and is largely practised for quick evaluation of the feed-stuffs.

Basis of physical evaluation

A ROUGHAGES

Physical evaluation of roughage is done on the basis of the following parameters.

(i) Leafiness
(ii) Stage of growth
(iii) Colour
(iv) Flavour and aroma

(v) Infections by fungs, moulds, etc.
(vi) Presence of weeds

Characteristics of some of the roughages

a) *Berseem:* Green fodder or berseem should be fed fresh, as far as possible. It should be leafy, cut at the right stage of maturity, i.e. its height should be about 45 cm. The colour should be dark green. Fodder kept for 24 hours after harvesting may develop moulds, fungus and a bad odour.

b) *Lucerne.* Another good quality fodder, lucerne should be cut at the same height as berseem. The colour should be dark green.

c) *Oats:* This is very leafy fodder. The colour should be green to dark green and it should be fed fresh.

d) *Sorghum:* Light green to green in colour at the proper feeding stage At maturity, the colour changes to yellowish. Sometimes, due to drought, the growth of the plants is stunted. Such crops should be avoided because they may contain hydrocyanic acid and if fed to animals, may cause poisoning and death.

e) *Maize fodder:* Green in colour. A yellowish colour indicates poor quality. It should be fed at the right stage of maturity i.e. from pre-flowering to the milky stage of grains

f) *Grasses:* Anjan grass, Napier grass and Para grass are good quality fodders. The colour should be green The grass should not be very fibrous These are good fodders when fed along with some leguminous fodder. These should be fed within 24 hours of cutting, otherwise they may develop fungal and mould infections and a bad odour. Such spoiled fodders are not liked by animals and may, sometimes, cause disorders in animals.

g) *Hay:* Green forages, when dried to about 80 to 85 per cent dry matter, are called hay. A good quality hay must keep the characteristic green colour of the crop. It should be prepared in such a way that there is less shedding of leaves due to shattering and the maximum amount of green colour is retained. The hay should be free from fungs, mould or bad odour. The aroma of the finished product should be such that it is relished by the animals. It should be dry so that it can be safely stored, without risk of fermentation or combustion. The most suitable crops for hay-making are oats, berseem, lucerne, cowpea, guar and cultivated grasses. Hay prepared from mature plants, is of an inferior quality.

h) *Silage:* The crops used for silage making are maize, oats, jowar,

bajra, teosinte, berseem, lucerne and natural grasses. Well fermented silage is bright, light green, yellow, green brown or *khaki* in colour. The odour is pleasant and vinegarlike. The texture is firm and the taste is sharp acidic. Seriously underheated silage has an olive-green or blue-green colour, strong, offensive rancid odour and offensive taste. Seriously overheated silage will have dark brown to black colour, strong burnt sugar or tobacco smell, dry texture and no specific taste. Both underheated and overheated silage is poor in quality.

i) Straw: Paddy straw, wheat straw, barley straw and oats straw are generally fed to livestock. In appearance these should be of golden yellow colour and should be completely dry. As far as possible there should be fewer node portions of the stem. Straw stored in wet conditions is likely to get spoiled and should not be used for animal feeding. The palatability of such straw is reduced due to the bad odour it develops.

j) Tree leaves: Leaves are fed either fresh or in dried form. Like hay, leaves in the dried form should retain their original colour and should be completely dry. Leaves are rich in tannins and are fed only as scarcity feed.

B. GRAINS AND OTHER CONCENTRATE INGREDIENTS

Physical evaluation of grains and concentrate ingredients is done on the basis of the following parameters.

(i) Appearance (size and shape)
(ii) Colour
(iii) Odour
(iv) Damaged and infested by insects/pests
(v) Infested with fungus, etc.

Characteristics of grams, concentrates by-products and minerals

a) Grains. Maize, barley, oats, sorghum and bajra grains are generally used as ingredients of concentrate mixtures. These grains should be natural in appearance, bold in shape, should not be shrunken, not too small in size, natural in colour, dry, intact and should not be damaged by insects and pests. Grains that are damaged by insects and pests are poor in nutritive value.

(b) *By products of cereal grains:* Wheat bran, rice bran, rice polish and *chunies* of gram, urad, arhar (tur) and moong are used for animal feeding. Each ingredient should have the original characteristic flavour of the grain from which it is produced. The colour should also be same as that of the covering of these grains or pulses. Like grains, these should

be dry and not in a moist or damp condition. There should not be any infestation with mould or fungus. Similarly, there should not be insects or pests in the feed ingredient.

(c) *Concentrate mixture ingredients of animal or marine origin:* Products like fish-meal, bone-meal, blood-meal and feather-meal of good quality should have the typical smell of that particular products. For example, fish-meal should have a fishy smell. All these products should not be wet or moist. They should also be free from adulterants.

(d) *Mineral mixture:* This is generally brown to red in colour. It should be dry and in fine powder form.

12.3 Precautions

— Avoid mixing of grains and feed ingredients while evaluating and storage.
— Take a representative sample for evaluation.
— Avoid a dark or damp place for the evaluation task.
— Keep green fodder, hay and silage separately.

12.4 Materials Required

A. ROUGHAGES
(i) *Green fodder:*
(a) Berseem
(b) Lucerne
(c) Oats
(d) Jowar
(e) Maize
(ii) *Hay*
(a) Lucerne hay
(b) Berseem hay
(c) Oats hay
(d) Hay from grasses
(iii) *Straw:*
(a) Wheat straw
(b) Paddy straw
(c) Barley straw
(d) Oat straw
(iv) *Grasses:*
(a) Anjan grass
(b) Para grass
(c) Napier grass
(v) *Tree leaves :*
(a) Pipal
(b) Bargad
(c) Neem
(d) Subabool
(vi) *Silage:*
(a) Maize
(b) Oats

B. CONCENTRATES
(i) *Grains:*
(a) Maize
(b) Barley
(c) Oats
(d) Jowar
(e) Bajra
(ii) *By-products of cereal grains:*
(a) Rice bran
(b) Rice polish
(c) Wheat bran
(d) *Dal chunnies*
(iii) *Oilseed cakes:*
(a) Groundnut cake

(b) Linseed cake
(c) Cotton seed cake
(d) Mustard cake
(e) Til cake

(iv) *Animal or marine origin products.*
(a) Fish-meal
(b) Bone-meal
(c) Blood-meal

(v) Mineral mixture
(vi) Pelleted feed

C. APPARATUS

(i) *Wide mouthed glass bottles or petri dishes.*

12.5 Procedure

— Place representative samples of green fodder, hay, straw, grass, silage and tree leaves on a *pucca* floor.
— Keep grains and other concentrate ingredients separately in wide-mouthed glass bottles or petri dishes.
— Observe, touch with fingers and smell each feed component.

12.6 Observations

The pupil should record the following:

A. Roughages (green fodder, dry fodder, hay, silage etc.

Sr No.	*Name of the feed*	*Leafiness (leaves are intact or shattered)*	*Stage of growth (pre-flowering, milky, maturity)*	*Colour (normal or abnormal)*	*Aroma (typical or a typical*	*Infected by moulds, fungi (Yes/No)*	*Presence of weeds (Yes/No)*	*Overall assessment*

B. Concentrate mixture ingredients

Sr. No	*Name of the feed*	*Appearance (large, medium or small in size, bold or shrunken, broken or intact)*	*Colour (typical or atypical)*	*Aroma (typical or atypical)*	*Damaged by insects or pests, etc (Yes/No)*	*Infested with fungi, moulds, etc. (Yes/No)*	*Proportion of small pieces of stones, bricks and mud, etc*	*Overall assessment*

12.7 Expected Behavioural Outcomes

Grade

The pupil will be able to:

— identify the feed components:

— evaluate the grains and feed components physically:

— examine the suitablitity of various feed components for mixing in the concentrate mixture.

The teacher should evaluate the pupil for the above abilities.

12.8 Questions

(i) Tick mark (✓) the correct answers:

(a) A good quality berseem fodder is: green/light green/yellowish green/dark green in colour.

(b) A good quality hay can be prepared from: Wheat straw/ oats fodder/lucerne fodder.

(c) Physical evaluation of maize grain can be done by: odour/leafiness/colour.

(d) The quality of silage can easily be evaluated by its:

(ii) *Fill in the blanks:*

(a) A good quality silage can be prepared from ————————

(b) Tree leaves are fed as —— ———— feed

(iii) Why are the grains and feed components evaluated physically?

(iv) What are the most important physical parameters, which are used for evaluating a feed component?

ACTIVITY UNIT : 13

Preparation of Compound Cattle Feed

13.1 Instructional Objectives

The pupil should be able to:

— recall the importance of balanced feeding;
— formulate feed for various classes of animals based on physiological functions;
— prepare compound cattle feed.

13.2 Relevant Information

Refer to Activity Unit 1, 12 and 14 for identification, physical evaluation of the ingredients and for calf starters and milk replacers before starting this Activity Unit.

Balance feed

A feed having all the required nutrients in the proper amount and proportion to meet the needs of the animal body, is called a balanced feed. The species for which it is intended and the functions such as maintenance or maintenance plus production shall be specified.

Complete feed

A nutritionally adequate feed for animals which is compounded by a specific formula, to be fed as the sole rations and is capable of maintaining life and/or promoting production without any additional substances being consumed except water, is called a complete feed. It includes both roughage and concentrate components.

Compound feed

A compound feed is composed of a number of feed ingredients. It could be a concentrate mixture or a balanced feed.

Pelleted Vs mesh feeds

Feeds are either produced in mesh or pelleted form. Poultry feeds are usually produced in mesh form, whereas cattle feeds are commonly produced in pelleted form.

Advantages of pellet feeds

— Pelleting prevents the ingredients from segregating.
— It does not allow the animal to

sort out certain ingredients and reject others.
- It reduces wastage of feed and loss of nutrients during storage.
- Pellets are less subject to infestation by insects and moulds.
- It reduces the possibility of adulteration of feeds with undesirable substances after pelleting.
- It is easy to handle.
- Pelleting kills unhygienic bacteria due to exposure to high temperature during processing.
- It increases the palatability and digestibility of feed.
- It reduces, to a certain extent, the microbial degradation of protein and preserves Vitamin A potency.

Feed formulation

In a cattle feed plant, one of the most significant aspects of production is to derive an appropriate formula to produce nutritionally balanced feed at the lowest possible cost. This formulation can be worked out either manually or by using computer facilities.

(a) Manual method: The Manual formula is generally worked out on a trial and error basis, with emphasis on nutritional balance. Such a formula may be nutritionally balanced but not necessarily the least expensive. The situation becomes further complicated with the ever increasing number of ingredients.

(b) Computerized least cost formulation: The linear programming technique is employed to test rapidly all possible permutations and combinations of available ingredients to select a least-cost feed mix which meets the desired nutritional requirements for a particular class of animals.

Feed formulation for various classes and physiological functions

Cattle feed factories manufacture feed for various physiological functions, e.g. milk replacer calf starter, grower mixture, etc.

(a) *Milk replacer and calf starter* · Refer to Activity Unit No. 14.

(b) *Compound feed formulae for cattle :* The commonly used formulae are .

(i) *For dry cattle/buffaloes :*

Barley	— 30 parts
Oats	— 30 parts
Gram	— 38 parts
Mineral mixture (containing salt)	— 2 parts
Total	— 100 parts
DCP	— 9%
TDN	— 70%

(ii) *For milch cattle/buffaloes :*

Barley grain	— 6.39 parts
Wheat bran	30.00 parts
Guar-meal extraction	— 15.00 parts
Cotton seed cake	— 19.39 parts
Til cake	— 14.54 parts

Molasses	— 10.50 parts
Calcium Carbonate	— 2.18 parts
Mineral + vitamin mixture	— 1.00 parts
Salt	— 0.50 parts
Total	— 100.00
DCP	— 15.70
TDN	— 65.83

Testing of raw materials and finished products ·

The quality control laboratory should be well equipped for testing of the raw materials and finished products. Since the purchase of raw materials for compounding feeds is based on this analysis, the highest degree of accuracy in the tests is desirable.

Finished products (compound feeds) should be analyzed for all the laid down nutrient specifications claimed by the manufacturer.

ISI specification for compounded cattle feed ·
(IS : 2032-1975).

The Bureau of Indian Standard (ISI) has prescribed the following specification for compounded cattle feed:

Moisture (maximum)	— 10%
Crude protein	— 20%
Crude fibre	— 13%
Acid insoluble ash (maximum)	— 4%
Digestible crude protein (DCP)	— 14-16%
Total digestible nutrients (TDN)	— 68-74%

Labelling of compounded feed bag

The compounded feed must be accompanied by a label bearing the following information as required by law :

(i) Net weight
(ii) Product name and brand name.
(iii) Guaranteed analysis as per specification.
(iv) The name and mailing address of the manufacturer.
(v) Adequate directions for use of all commercial feeds.

Certain apprehensions and notions of the farmers about compounded feeds

(a) Loss in weight : When feed is despatched from the factory, it has a moisture content of 9-10 per cent. If it is kept for longer time, there is a slight loss of weight. However, in case of higher loss, the matter may be reported to the supplier

(b) Reduction of fat % in milk: Many farmers complain that the fat percentage in milk decreases when compounded cattle feed is fed to animals. This may be a temporary phase due to the change in the feeding regime as fat percentage in milk recoups gradually

(c) Reduction in milk yield : Any new feed should be introduced

gradually. Otherwise, animals may not take it and it may affect the milk yield.

(d) Decline in quality of ghee : The quality of ghee is not affected. It is the size of fat globules which is affected.

(e) Low conception rate : Compounded cattle feed has no adverse effect on the conception rate of animals.

(f) Tympany, indigestion and diarrhoea : These diseases are not related with the feeding of compound feed. There may be other causes for these diseases.

(g) Old and torn bags : Generally new bags are used in a factory for packing the compound feed. Sometimes, due to strikes in the jute mills, or some other problem old bags are also used.

13.3 Precautions

- Check the processing plant thoroughly before starting it. Follow the feed formula strictly.
- Keep the plant free from dust.
- Do not smoke in the feed plant.
- Close all the doors of the plant tightly.
- Replace flexible canvas/rubber sleeves as soon as they are found worn out.
- Clean the magnets of the plant regularly.
- Do not carry out any repair work on a machine in motion.
- Do not carry out welding or gas cutting inside the plant if the plant is not stopped and cleaned of powder residues.
- Ensure that nothing has caught fire after completing welding/gas welding work.
- Avoid naked electric wires and temporary wiring.

13.4 Materials Required

(i) Feed ingredients and supplements as per feed formula.
(ii) Quality Control Laboratory (See Activity Unit 19).
(iii) Feed plant consisting of weighing balance, grinder, mixer and pellet machine facilities.
(iv) Bagging facility
(v) Stores
(vi) Fire extinguishers
(vii) Water supply
(viii) Electricity

13.5 Procedure

- Procure specified raw materials at reasonable cost.
- Store the raw materials properly.
- Have quality tests done of the raw materials.
- Weigh ingredients as per feed formula and keep them separately.
- Check the plant before operation.
- Grind the raw materials and mix them properly in the mixer.
- Feed the ingredients to the pellet machine.
- Check the uniformity of pellets.
- Allow the pellets to cool.
- Fill the pellets in bags and then stitch them up.

— Obtain a sample of the finished product (pellets) from each bag and send for quality control tests.
— Store the bags properly after labelling.
— Keep all records.
— Leave the plant cleaned through the aspiration system.

13.6 Observations

The pupil should ensure the following and note down anything else they observe.

— Adequate supply of feed ingredients.
— Plant is running to full capacity.
— Mixing is proper.
— Pellets produced are of uniform size.
— Sampling is proper.
— Weight of bagged material is correct.
— Bags are properly stitched and labelled.
— Storage of bags is proper.
— Records are maintained properly.

13.7 Expected Behavioural Outcomes

The pupil will be able to:

— recall the importance of a compound feed;
— formulate rations for different categories of animals;
— participate in the working of a feed factory;
— prepare compound cattle feed.

Grade

The teacher should evaluate the pupil for the above abilities.

13.8 Questions

(i) Differentiate between .
  (a) Balance feed and complete feed
  (b) Pellets and mesh
(ii) Give the advantages of pelleting feeds.
(iii) What are the various methods of feed formulation?
(iv) Why should the plant be checked before starting?
(v) What is the advantage of proper mixing of feed ingredients?
(vi) How are the quality control measures useful in a feed factory?
(vii) What is the importance of labelling?
(viii) Why are there complaints against compounded feed by the farmers?

ACTIVITY UNIT ; 14

Preparation of Milk Replacers and Calf Starters

14.1 Instructional Objectives

The pupil should be able to :

— recall the importance of milk replacers and calf starters;

— recall the advantages of weaning calves;

— explain various methods of feeding calves, from teats and by milk replacers;

— prepare the milk replacers and calf starters on the basis of local ingredients.

14.2 Relevant Information

Weaning :

After birth, the calves must exhibit true increase in structural tissue growth in terms of increase in the number and size of cells. Weaning is the process by which calves are removed from the mother, either at birth or when they are four days old and reared separately to get optimum nutrients. This helps in feeding the calves properly. Judging the adequacy of feeding by suckling is difficult, and both under-feeding as well as over-feeding are harmful for growth. After weaning, the calf is trained to take milk from a pail, either by a hollow pressure rubber tube or a nipple. Some hesitant calves are made to take milk with the help of one or two fingers inserted in the mouth.

Milk replacers :

A milk replacer is a constituted feed and is obviously cheaper than milk. It can substitute milk for feeding young calves. The calf, at an early age cannot consume bulk feed, and, thus, requires a milk replacer which can be fed on milk dry matter equivalent basis. Further, a milk replacer should resemble, more or less, the broad composition of milk

in terms of protein quantity and quality, amino acids quantity and quality, volatile fatty acids, minerals and vitamins. It should have a nutritive value equivalent to milk and its ingredients should be low in crude fibre The replacement of milk replacer should be gradual, in order to avoid a drop in growth rate. A milk replacer should also include antibiotics as additives to stimulate growth and build up resistance against disease.

Calf starters :

When a calf is 90 days old and has been cared for and fed well, it should weigh between 50-60 kg in the case of females and 60-70 kg in the case of males. Calves also develop their rumen for microbial fermentation. It may not be necessary to feed milk or milk replacer at this age because of the high cost of feeding. A concentrate mixture with a high protein content, known as calf-starter, should be fed. At this stage, the calves will also consume some good quality fodder. A calf starter containing 22 per cent crude protein (18 per cent digestible crude protein approx) and having 75 per cent TDN (Total Digestible Nutrients) value may be fed when the calf is three months old. A high quality calf starter is necessary along with an adequate quantity of minerals and vitamins.

14.3 Precautions

— Ensure that the ingredients are free from pests and visible fungus.
— See that the moisture content of the ingredients does not increase beyond 12 per cent.
— Ensure that all the ingredients of the milk replacer are in powder form.
— Store the replacers and calf starters in a dry and cool place.
— Ensure that the grains and cakes are in ground form for starters.

14.4 Materials Required

(i) Ingredients of milk replacer—wheat, fish-meal, linseed-meal, milk powder, coconut oil/ cottonseed oil, linseed oil, citric acid, molasses, mineral mixture, butyric acid, antibiotics and Rovimix A, B_2 and D_3.
(ii) Ingredients for calf starter—maize, groundnut cake, fish-meal, wheat bran and mineral mixture.
(iii) Gunny bags, preferably lined with polythene.
(iv) Pulverisor.

14.5 Procedure

(a) *Milk replacer :*
— Take the following ingredients :

Wheat : 10.0 kg
Powder form
Fish-meal: 12.0 kg
Linseed-meal : 40.0 kg
Milk (dry basis) : 13.0 kg
Coconut oil/cotton seed oil : 7.0 kg

Linseed oil	3.0 kg
Citric acid	1.5 kg
Molasses	10.0 kg
Mineral mixture	3.0 kg
Butyric acid	0.3 kg
Antibiotics	0.3 kg
Rovimix A, B_2, D_3	0.15 kg
Total	100.25

— First, mix oils, acids, antibiotics, vitamins and molasses.
— Then add this material slowly to the rest of the ingredients. Mix them thoroughly.
— In the case of a small quantity, say up to one quintal, mix by hand, otherwise use a pulverisor.
— Fill in the bags and keep in a dry, cool place.

(b) *Calf starter :*

— Take the following ingredients :

Maize	42 kg
Groundnut cake	28 kg
Fish-meal	7 kg
Wheat bran	20 kg
Mineral mixture	3 kg
Or	
Maize	30 kg
Linseed cake	40 kg
Fish-meal	7 kg
Rice bran	10 kg
Wheat bran	10 kg
Mineral mixture	3 kg
Or	
Maize	35 kg
Groundnut cake	42 kg
Wheat bran	20 kg
Mineral mixture	3 kg
Or	
Barley	17 kg
Linseed cake	60 kg
Wheat bran	10 kg
Rice bran	10 kg
Mineral mixture	3 kg

— Mix the ingredients thoroughly.
— Weigh after mixing.
— Fill in bags and store in a dry, cool place.

14.6 Observations

The pupil should observe and record the following:

(a) Moisture content
(b) Presence of insects, pests and fungi
(c) Flavour
(d) Colour
(e) Weight

14.7 Expected Behavioural Outcomes

The pupil will be able to :

— recall the importance of milk replacers and calf starters;
— recall the advantages of weaning;
— explain the methods of feeding calves;
— prepare the milk replacers and calf starters.

Grade

The teacher should evaluate the pupil for the above abilities.

14.8 Questions

(i) Tick mark (✓) the correct statement

(a) Milk replacers and calf starters are the same thing.

(b) A replacer should have the same nutrients as milk

(c) Vitamins and antibiotics are not required to be mixed with milk replacers.

(d) Milk replacers contain high fibre and low protein.

(e) Milk replacers or calf starters are given immediately after birth.

(f) Milk replacers should be mixed in water at body temperature.

(g) Calf starters should be fed after the calf is 90 days old.

(h) Calf starters usually contain 18% DCP and 75% TDN.

(i) Calf starters may contain 25% animal protein.

(j) The replacers or starters can have any moisture content.

(ii) Fill in the blanks:

What are the ISI standards in the case of:

a. Milk replacers . . . . . DCP . . . . . .TDN . . . . Moisture . . . . .

b. Calf starters . . . . DCP . . . . . TDN . . . . . .Moisture . . . . .

(iii) Why should the ingredients in milk replacers be in powder form?

(iv) Why should the starter not be in powder form?

(v) What will happen if calf starters are fed to new-born calves?

ACTIVITY UNIT : 15

Preparation of Schedule for Feeding of Calves

15.1 Instructional Objectives

The pupil should be able to :

- recall the importance of proper feeding for optimum growth;
- recall the various feed ingredients required for the preparation of the feeding schedule;
- recall the factors affecting growth;
- prepare economic feeding schedules;
- feed the calves.

15.2 Relevant Information

Growth :

By definition, growth is the increase in body mass per unit of time. During the pre-ruminent stage(upto two months of age) cow and buffalo calves grow satisfactorily on whole milk feeding at the rate of one tenth of the body weight. The success of cattle breeding projects depends upon the fast rearing of calves to a breedable age, with minimum mortality. All species exhibit an optimum growth rate, as per their hereditary characteristics, with proper nutrition and management. The birth weight is closely related to growth rate.

Proper Nutrition :

Nature has provided milk for calves which is of high nutritive value. After weaning at birth;calves should be fed colostrum within 2 hours and feeding should be continued for 4 days. It is essential to provide antibodies through colostrum which are absorbed intact in just a few days of the calf's life. Its high nutritive value and its laxative action to remove the first faeces are also important. In case the mother does not give colostrum, a substitute of equal nutritive value of 2 eggs with an ounce of castor oil may be fed.

The calves, fed with milk, show best feed-efficiency i.e. 1 kg gain per 1.39 kg dry matter in milk. It is possible to stipulate the requirements of a calf from the chemical composi-

tion of milk for scientific feeding. Milk is more or less a complete food for the calf, to which the gastro-intestinal system is adapted for digestion of the nutrients present in it. It has been emphasized that a calf must receive sufficient milk during the first 3 months or a minimum of 110 litres of whole milk to be fed over a period of 4 to 5 weeks along with a calf starter with good quality protein and low fibre contents (Refer to Activity Unit 14). It has been further suggested that a minimum of 160 litres of whole milk feeding up to 7 to 10 weeks of age, in addition to colostrum, is necessary.

Similarly, calves can also be raised economically by feeding a restricted milk quantity. Whatever may be the milk feeding schedule, it is important to consider certain factors which affect the growth rate such as;

- birth weight,
- quantity of whole milk,
- sex, and
- heredity.

In weaned calves, warm milk should be given at body temperature, preferably with trace mineral supplements to make up the deficiency of Fe, Cu, Mg, Mn and Zn which are deficient in milk. Green fodder, up to 100 g dry matter, may be offered daily from 15 days of age onwards, so that a calf can get a stimulus to develop its rumen.

15.3 Precautions

- Ensure inclusion of colostrum in the schedule
- See that the milk is fresh.
- Ensure that the milk is kept at body temperature.

15.4 Materials Required

(i) Paper
(ii) Pencil
(iii) Information about the calves under various age groups
(iv) Types of feed available
(v) Composition of milk replacer and calf starter
(vi) Colostrum.
(vii) Antibiotics
(viii) Milk measure
(ix) Milk replacer
(x) Dry cloth
(xi) Savlon
(xii) Salt

15.5 Procedure

(a) *Schedule with milk*

- Study the available information
- Take note of the types of feed available
- Prepare the schedule for calves from 0-4 days, up to 30 days, up to 60th day
- and onwards.
- Follow either of the schedules given on the next page for milk feeding.
- Feed each calf with 30 mg of antibiotics per day.
- Feed measured quantity of milk.

Milk Feeding Schedule I

Age (days)	*Colostrum*	*Milk*
0—4	1/10 of body weight	—
Above 4	—	1/10 of body weight up to 60 kg

Milk Feeding Schedule II

Body wt. (kg)	*Age (days)*	*Colostrum*	*Milk*
Upto 30	0—4	1/10th of	—
Upto 30	5—90	body weight	1/10th of body weight
31—60	—	—	1/20th of body weight

Milk Feeding Schedule III

Body wt. (kg)	*Age (days)*	*Colostrum*	*Milk*	Separated *milk*
Upto 30	0—5	1/10th of	—	—
Upto 30	6—30	body weight	1/10th of body weight	—
25—50	31—60	—	1/15th of body weight	1/25th of body weight
35—70	61 –80	—	1/25th of body weight	1/25 of body weight

— Wipe the calf's mouth with a cloth dipped in savlon water.
— Rub salt on the calf's tongue.
— Start giving good quality green fodder or hay after the calf is one week old.

(b) *Schedule with milk and milk replacer*

— Feed colostrum at birth at the rate of 1/10th of body weight.
— Follow the schedule as given on p. 64.
— After a week, start giving greens or hay.
— At 90 days of age, feed the

Feeding schedule of calves fed with milk and milk replacer

Age (days)	*Body weight*	*Colostrum*	*Milk (litres)*	*Milk replacer (g)*
0—5	—	1/10th of Body wt.	—	—
6—9	—	—	1/10th of body wt.	—
10—13	—	—	— do —	50
14—17	—	—	— do —	100
18—21	—	—	0 5	175
22—25	—	—	1 0	250
26—29	—	—	1 5	325
30—33	35	—	2.0	400
34—36	40	—	2 5	500
	40	—	1.5	600
	45	—	1.5	700
	50	—	1.0	800
	55	—	1.0	900
	60	—	1.0	1000
	75	—	1.0	1000

calf with high quality succulent fodder, *ad lib* along with 1 kg of starter.

15.6 Observations

The pupil should record the following while feeding the calves:

- Measurement of milk and replacer/starter feed and weight of individual calf daily
- Growth records fortnightly
- Diarrhoea cases
- Other sickness symptoms
- Birth and mortality
- Cleanliness and freshness of drinking water

15.7 Expected Behavioural Outcomes

The pupil will be able to:

- recall the components of the schedule;
- prepare a feeding schedule for calves;
- feed the calves.

Grade

The teacher should evaluate the pupil for the aboye abilities.

5.8 Questions

(i) Tick mark (✓) the correct statement

(a) Colostrum feeding is essential at birth.

(b) Colostrum can be fed any time within 24 hours of birth.
(c) The temperature of milk is not important in feeding.
(d) The milk should be fed @ 1/10 of body weight from birth to 3 months of age.
(e) Antibiotics are not necessary for feeding calves.
(f) Feeding of succulent green fodder helps in the development of rumen.
(g) Measurement of growth rate is important.
(h) The mouth of the new-born calf should be wiped with a cloth soaked in Savlon.
(i) It is necessary to rub salt on the tongue of the new-born calf.

(ii) What is an average birth weight of a calf?
(iii) Why should colostrum be fed to the new-born calf?
(iv) What do you mean by an antibiotic?
(v) How much should the milk replacer be diluted with water?

ACTIVITY UNIT : 16

Computation of Rations for Different Categories of Livestock

16.1 Instructional Objectives

The pupil should be able to :

- recall the nutrient requirements of dairy animals for different functions;
- recall the nutritive composition of commonly used feed ingredients;
- compute/formulate balanced rations for different categories of dairy animals.

16.2 Relevant Information

Formulation/computation

Formulation or computation is the mathematical means used to derive a balanced diet that will provide appropriate quantities of biologically available nutrients at low cost.

Least cost feed formulation

It is one of the different means to derive balanced rations through the use of linear programming by computer.

Compounding or mixing

Compounding is a mechanical process by which different ingredients are put in a common mixture. Each small amount of the mixture has the same proportion of each ingredient as the original formula. When the formula is simple, mixing is also simple (refer to Activity Unit No. 13).

Formula feed

Formula feed is a feed consisting of two or more ingredients mixed in specified proportions.

Formulation of rations

The rations formulation for dairy animals depends on the type of feeds and fodders available and the requirement of the nutrients for a particular animal or group of animals. The nutrient requirements are largely based on the size of the animal and its physiological status, i.e. growth, preg-

nancy or milk production. The rations should meet the energy, protein, mineral and vitamins requirements of the animals, when consumed in sufficient quantity. Therefore, it is essential to formulate rations having enough flexibility to accommodate diverse situations of availability of feeds and fodders and their cost.

Some important information regarding feed formulation

During formulation of feed for dairy cows or buffaloes the following points must be kept in mind :

(a) Requirement of the different nutrients including energy. Requirements for a dairy cow cannot be taken directly from the specification table but must be calculated after considering the requirements for maintenance (including growth and foetal development, if involved) and an additional set of requirements for milk production based on the amount of the milk produced and its fat content (Refer to Annex III, IV, V and VI.

(b) Daily feed intake should provide the requirements and also the bulk. On an average a dairy cow or buffalo will eat 2.5—3.0 per cent dry matter of her body weight.

(c) Feed stuffs available in the farm/local market, their costs, nutrient composition (refer to Annex I & II) and safe/effective inclusion levels.

(d) The ingredients used in a formula should not affect the keeping quality after mixing.

(e) Adequate supply of greens mineral mixture and common salt to the dairy cows.

Digestible crude protein (DCP) : This is that amount of total curde protein of a feed which is actually digested and absorbed by the animal.

Total digestible nutrients (TDN) : This is the sum of digestible crude protein (CP), digestible crude fibre (CF), digestible Nitrogen free extract (NFE) and digestible ether extract (EE) multiplied by 2.25.

%TDN of a feed=% digestible CP+% Digestible CF+% Digestible NFE + % Digestible EE × 2.25.

16.3 Precautions

— Make the formula simple and flexible
— Take care of all the nutrients especially DCP, energy, Ca, P, Salt and Vit. A.
— Take care of intake per unit time (palatability).
— Use the ingredients available at the farm as per the formula considering the comparative cost.
— Ensure input and output relationship in the formulation.

16.4 Materials Required

(i) Feed composition tables (refer to Annex I & II)

(ii) Nutrient requirement specification tables (refer to Annex III, IV, V and VI)
(iii) Type and quality of feed ingredients/ fodders
(iv) Fodder source i.e. green/dry roughage
(v) Data related to growth, milk production, gestation, etc.
(vi) Hand calculator, if available

16.5 Procedure

— Calculate the nutrient requirements in terms of energy and protein for the cow or buffalo to be fed.
— Ensure the availability of the feed ingredients to be used.
— Find out the nutritive composition, the cost of the ingredients and their levels of inclusion.
— Calculate the quantities of different feeds and fodders which will supply the required nutrients calculated in the first step.
— Take into account the animal's capacity to consume feed.
— Lastly, add mineral mixture, and common salt @ 2 and 1 kg/100 kg, respectively, of concentrate feed formula.

16.6 Observations

The pupil should record the following :

— Weight of the animal for which the rations is to be formulated.
— Physiological status of the animal i.e. growth, gestation and milk production.
— Rate of activity like daily gain, daily milk production, fat percentage in milk, stage of pregnancy, etc
— Feed ingredients, their nutritive values and cost

16.7 Calculations

The pupil should compute a concentrate mixture and balanced rations for a milch cow.

I. Compute a concentrate mixture having 17% DCP and 70-71% TDN using the following ingredients.

(i) Groundnut cake
(ii) Wheat bran
(iii) Barley
(iv) Mineral mixture
(v) Salt

Step 1 . Decide the amounts of mineral mixture and common salt to be added. Mineral mixture and common salt are added @ 2 and 1%, respectively Therefore, the desired nutrients (DCP and TDN) will come from 97% of the rations.

Step 2 : Set feed ingredients with their quantities to be added and calculate DCP and TDN supplied by them as under :

Step 3 : DCP requirement is 17%. Therefore, 17.37–17 = 0.37% of DCP is to be reduced. Replace groundnut cake with wheat bran. The difference in DCP of 100 parts. of the first two ingredients is 41.8-

	Parts	*DCP*	*TDN*
Groundnut cake	28	11 70	19 88
Wheat bran	27	2.86	18 22
Barley	42	2 81	32.63
Total :	97	17.37	70.73

	Parts	*DCP*	*TDN*
Groundnut cake	26 8	11.20	19 03
Wheat bran	28 2	2.99	19.03
Barley	42.0	2.81	32.63
Total	97.0	17.00	70.69

The composition of concentrate mixture will be ·

Groundnut cake	26.8 parts
Wheat bran	28.2 parts
Barley	42.0 parts
Mineral mixture	2.0 parts
Common salt	1 0 parts
	100.00

10.6 = 31.2. Hence, if we reduçe or replace 0.37/0.312=1.2 part groundnut cake with wheat bran, the DCP will be 17%.

II. Compute a ration for a non-pregnant cow of 400 kg body weight producing 10 kg of milk containing 4% fat.

Step 1 : Calculate the requirements of DCP and TDN as follows :

Step 2 : Calculate the quantities of different feeds and fodders which will supply the nutrients set up in Step I. A cow consumes dry matter

Physiological function	*DCP (kg)*	*TDN (kg)*
Maintenance	0.245	3.1
Milk production	0.510	3.3
Total :	0.755	6.4

@ 2.5—3% of her body weight. Thus, the cow of 400 kg body weight, will consume
4×2.5—3 or 10-12 kg
dry matter per day.

The maintenance requirement can be met from one of the following two feed combinations :

(a)	Wheat *bhusa*	5 kg
	Green berseem	12 kg
	DCP	250 g
	TDN	3.2 kg
(b)	Wheat *bhusa*	2.5 kg
	Green jowar	15 kg
	DCP	270 g
	TDN	3.2 kg

The requirements for milk are to be met by a concentrate mixture. Therefore, 4 kg concentrate mixture (14% DCP) should be added to the maintenance rations in order to provide the needed energy and protein for the production of 10 kg of milk (refer to Annex VII).

16.8 Expected Behavioural Outcomes

The pupil will be able to :

— recall the nutritive value of different feed-stuffs;
— calculate the nutrient requirements of dairy animals;
— formulate concentrate mixtures of different nutritive value;
— calculate the quantity of feed-required ;
— formulate rations for dairy animals.

The teacher should evaluate the pupil for above abilities.

Grade

16.9 Questions

(i) What do you understand by the terms 'DCP' and 'TDN'?
(ii) Formulate a concentrate mixture having 14% DCP and 70% TDN.
(iii) Compute rations for a non-pregnant buffalo of 500 kg body weight, producing 10 kg milk of 6% fat.
(iv) Name the important nutrients to be taken care of during computation of rations.
(v) What do you understand by 'palatability'?
(vi) Write down the dry matter consumption per 100 kg body weight by different categories of animals.
(vii) What is input and output relationship?

ACTIVITY UNIT · 17

Preparation of Mineral Mixtures

17.1 Instructional Objectives

The pupil should be able to :

— recall the role of minerals in the body;

— differentiate between macro and micro mineral elements;

— formulate a mineral mixture for feeding to the animals.

17.2 Relevant Information

Minerals and their importance in animal nutrition

In addition to protein, fat, carbohydrates and vitamins, the mineral elements are also required in the rations of farm animals. Minerals are required for various metabolic functions in the body. They are present in the animal body as organic and inorganic compounds. Sodium chloride, calcium phosphate and calcium carbonate are present in the body as soluble ionized salts or electrolytes in body fluids or as crystals in structural parts. The organic forms of these minerals are found in proteins, lipids, lipids, carbohydrates and other compounds.

Essential mineral elements

The minerals which have been proved to have an essential metabolic role in the animal body are of two types : (1) Macro or major elements, for example, calcium, phosphorus, potassium, sodium, chlorine, magnesium and sulphur are those which are required by the body in higher amounts. (2) Micro or trace elements are for example, iron, cobalt, zinc, manganese, copper, iodine, molybdenum and selenium. These minerals are equally important for the proper functioning of the animal body, but since these are required in very small amounts, they are called trace elements.

Role of minerals in the body

Some minerals like calcium, phosphorus, etc. are constituents of the skeletal structure. Certain minerals

are also constituents of organic compounds such as proteins and lipids which make body tissues. Some minerals regulate body fluids through the maintenance of body pH, osmotic pressure, ion exchange permeability of cell membrane and maintenance of colloidal state. They may play a biochemical role, like iron in haemoglobin, phate and many other minerals Feeds and Feeding Dairy Animal enymes and hormones.

Why is a mineral mixture needed in the rations of animals?

Due to extensive cultivation of various crops, there is a deficiency of certain minerals in the soils of certain parts of our country. With the result. that the feed material which grows in such soil may be deficient in one or more minerals. Also, the mineral requirement of the animal body increases during the growing period, advanced pregnancy and lactation, and the feeds available may not meet the requirement. The deficiency of mineral elements, especially the trace elements, besides other nutritional factors, is responsible for the poor health and low productivity of livestock.

Soils are deficient in zinc in parts of Punjab, Uttar Pradesh, Andhra Pradesh, Rajasthan, Tamil Nadu and Haryana. The maximum area of deficiency has been reported from Punjab and Rajasthan. Copper is deficient in parts of Tamil Nadu and Punjab. Manganese is deficient in parts of Punjab. Thus, to avoid any dificiency of minerals in the animal body, the feeds are supplemented with mineral mixture

(i) Rickets : This is primarily due to deficiency of calcium, phosphorus and Vitamin D in the rations of calves. In this disease the bones are mis-shaped and there is enlargement of the joints, stiffness and lameness In severe and prolonged deficiency, breaking of ribs also takes place. The disease is common in piglets and calves.

(ii) Osteomalacia : This is a disease of adult animals in which the bones become porous and soft. Continuous mobilization of calcium from the bones for higher demand elsewhere in the body, due to a low dietary intakes, is responsible for this condition. In poultry, deficiency of calcium result in soft bones and beaks.

(iii) Pica : Due to deficiency of phosphorus in the rations, animals develop an abnormal appetite due to which they eat wood, bones, rags, hair, etc.

(iv) Goitre : In this disease the thyroxine hormone production is very much reduced. In order to produce more thyroxine for physiological functions, the thyroid gland enlarges. This is due to iodine deficiency in the rations.

(v) Anaemia : In this disease, there is laboured breathing, the

haemoglobin level of the blood falls to 3-4 g per 100 ml of blood against the normal levels of 12-14 g per 100 ml. The growth rate is affected. This disease is mainly due to iron deficiency. Copper helps iron utilization in the body. Since more than half of the iron present in the body occurs in the haemoglobin of blood, iron deficiency affects the formation of haemoglobin, resulting in anaemia. In ruminants, iron deficiency is not common.

(vi) Milk fever : This disease is due to calcium deficiency arising from hormonal imbalance in high milk producing cows. Shortly after parturition, high yielding cows suffer from milk fever. The serum calcium level goes down, with the result that there is muscular spasm and, in extreme cases, paralysis occurs. Intravenous injections of calcium gluconate restore the normal levels of calcium in the blood and the animal is cured.

17.3 Precautions

— Use pure and dry ingredients for preparation of mineral mixture.
— See that the mixer or grinder are clean.
— Ensure proper mixing of trace elements.

17.4 Materials Required

(i) Grinder
(ii) Mixer
(iii) Nylon lined bags and stiching or sealing materials
(iv) Ingredients (salts)
  (a) Dicalcium phosphate
  (b) Sodium chloride
  (c) Chalk
  (d) Magnesium carbonate
  (e) Ferrous sulphate
  (f) Copper sulphate
  (g) Manganese dioxide
  (h) Cobalt chloride
  (i) Potassium iodide
  (j) Sodium fluoride
  (k) Zinc sulphate
(v) Weighing balance

17.5 Procedure

— Note down the colour, solubility and form of each available salt.
— Weigh the exact quantity of each ingredient (salt). For preparation of 3 kg of mineral mixture, the following quantity of various salts is required :

	(kg)
Dicalcium phosphate	1.6500
Sodium chloride	0.9000
Chalk	0.3312
Magnesium carbonate	0.0900
Ferrous sulphate	0 0150
Copper sulphate	0.0021
Manganese dioxide	0.0021
Cobalt chloride	0.0015
Potassium iodide	0.0003
Sodium fluoride	0.0003

Zinc sulphate	0.0075
Total	3.0000 kg

— Grind each ingredient in a grinder to a powder form
— Mix all the ingredients in a mixer.
— Fill the mineral mixture in plastic/ nylon bags.
— Stich or seal the bags properly.
— Store in a dry and cool place.

17.6 Observations

The pupil should record the following :
— Name of the salts
— Colour of the salts
— Solubility of the salts
— Form of the salts
— Colour after grinding and mixing of all the salts

17.7 Expected Behavioural Outcomes

The pupil will be able to :
— recall the role of minerals in the animal body;
— differentiate between macro and micro mineral elements;
— prepare mineral mixture

The teacher should evaluate the pupil for the above abilities.

Grade

17.8 Questions

(i) Tick mark (✓) the correct answers :

(a) In addition to protein, fat and carbohydrate, the following nutrient(s) is/are required by the animals: minerals/vitamins/both
(b) Major or macro minerals are: calcium / iron / phosphorus/ magnesium/copper.
(c) Micro or trace elements are sulphur/chloride/sodium / cobalt/iodine/zinc.
(d) Essential mineral elements are : Fluorine/nitrates/chromium/ tin/vanadium/silicon

(ii) Fill in the blanks :
(a) Rickets is caused by the deficiency of ( ) in the rations.
(b) Pica is caused by the deficiency of ( ) in the rations of animals.
(c) Goitre is caused by the deficiency of ( ) in the rations of . . . . .

(iii) Explain why minerals are needed in the rations of milch animals?
(iv) Why is it essential to have mineral ingredients in dry form for the preparation of mineral mixtures?
(v) Why should mineral mixtures be stored in a cool and dry place?
(vi) Why are calcium and phosphorus important in the rations of animals?

ACTIVITY UNIT : 18

Calculation of Feed and Fodder Requirements of a Dairy Farm having Five Dairy Cows with Dependents

18.1 Instructional Objectives

The pupil should be able to :

- recall the importance of forage feeding to dairy animals;
- calculate the yearly feed and fodder requirements for dairy animals

18.2 Relevant Information

An assumption

A dairy unit of 5 cows should consist of 3 cows in milk, 2 dry cows, and roughly 3 young calves and 2 heifers or young bulls.

Dry matter (DM) consumption :

The milch cows consume dry matter @ 3% of their body weights while the dry cows and heifers or young bulls consume about 2% and 2.5%, respectively of their body weight. This dry matter is usually supplied to the animals through roughage and concentrates.

The young calf is provided calf starter for the first 4 months and allowed to nibble the forages. However, concentrate mixture and good quality fodder are offered to calves after 4 months.

Refer to Activity Unit 1 and 12 for identification and evaluation of feed-stuffs.

18.3 Precautions

- Do not calculate the requirements on the basis of dry fodder only.
- Keep enough provision of greens and supplement with silage and dry fodders
- Note that mixed fodder makes the rations balanced.

18.4 Materials Required

(i) Notebook
(ii) Pencil

18.5 Procedure

- Assume the appropriate weight of milch and dry cattle and their dependents.
- Calculate per day dry matter requirement of the animals.
- Convert the DM equivalent to mixed green fodder.
- Calculate the requirement of concentrate mixture and calf starter suitably, assuming per day requirement

18.6 Calculations

The pupil should calculate the green fodder, calf starter and concentrate requirements.

Green fodder requirement :

No. of milch animals	= 3
No. of dry animals	= 2
No. of heifers	= 2
No. of young calves	= 3

Average body weight of cows	= 350 kg
Average body weight of heifers or young bulls	= 200 kg
— Daily DM consumption of 3 milch cattle @ 3% body weight	= 31.5 kg
— Daily DM consumption of 2 dry cows bulls @ 2.0% body weight	= 14 kg
— DM consumption of 2 heifers or young bulls @ 2.5% body weight	= 10 kg
Total	= 55.5 kg
— DM content in mixed forages	= 20%
— Green fodder requirements	= $\frac{55.5 \times 100}{20}$ = 277.5 kg Say 2.80 quintals
— Green fodder requirements/year	= 2.8×365=2920 quintals
— Green fodder for 3 calves for 8 months @ 5 kg/day/calf as for the first four months they will survive on calf starter	= 36 quintals
— Total green fodder requirement	= 2920+36 = 2956 quintals = Approximately 3000 quintals.

Calf starter and concentrate requirement

— Requirement of calf starter for 3 calves @ ½ kg/day (1st month) = 45 kg
— Requirement of calf starter for 3 calves for the next 3 months @ 1 kg/day/calf. = 270 kg
— Total calf starter requirement/year = 3.15 quintals
— Concentrate mixture for 3 calves for 8 months @ 1 kg/day/calf = 7.20 quintals
— Requirement of concentrate mixture for 3 milch cows/day @ 2 kg/cow. = 6 kg
— Requirement of concentrate mixture for 3 milch cows/year = 21.90 quintals

Total requirement of feeds/years :

— Green fodder = 2920+36=2956 quintal
Say 3,000 quintals
— Calf starter = 3.15 quintals
Concentrate mixture = 21.90+7.20 = 29.10 quintals
Say 29 quintal

18.7 Expected Behavioural Outcome

The pupil will be able to

— Calculate feed and fodder requirements of dairy animals.

The teacher should evaluate the pupil for the above ability.

18.8 Questions

(i) What should be the proportion of milch and dry cows on a farm?
(ii) Can you keep all the cows in milk without any dry ones or their followers?
(iii) Give the range of DM intake per 100 kg body weight—milch cow .... dry cow ..... heifer .. ... calf .. . . pregnant cow .....
(iv) Why can you not feed only dry fodder?
(v) How many calves are expected in a herd of 5 cattle?

ACTIVITY UNIT : 19

Organization of a Feed Analysis Laboratory Including its Equipment, Glassware and Chemicals

19.1 Instructional Objectives

The pupil should be able to :

- recall the importance of feed analysis;
- identify the equipment, glassware and chemicals;
- organize and maintain a feed analysis laboratory.

19.2 Relevant Information

Significance of feed analysis :

Chemical analysis of feed-stuffs provides the nutritive value of feed i.e. the potentiality of the feed to provide the required nutrients. This is essential in order to prepare a quality but economical feed. Due to increasing feed costs, the adulteration of the ingredients is also not uncommon. Therefore, quality control of various ingredients of feed-stuffs and of various types of compounded feeds is of great economic importance.

Location :

The laboratory should be centrally located so that it is easily accessible. It should be well ventilated and provided with adequate lights, exhaust and ceiling fans. However, direct sunlight should not enter into the laboratory.

19.3 Precautions

- Switch off all the electric points water taps and gas connection before leaving the laboratory.
- Avoid wastage of water, electricity, gas and reagents.
- Handle the glassware and reagents carefully
- Keep a first-aid-box ready.
- Ensure the use of proper electric wires.
- Avoid using open terminals or electric wires.
- Avoid smoking in the laboratory.
- Use an effective fume removal

device.
- Avoid contact of reagents with skin.
- Set up all equipment/apparatus on firm support and secure all connections.
- Dispose of waste materials regularly.
- Do not pipette hazardous liquid by mouth suction.
- Protect hands with a thick towel or gloves while inserting glass tubing into cork or rubber stoppers
- Wear acid-resistant gloves

19.4 Materials Required

(a) *Reagents*

(i) Petroleum ether/petroleum spirit—(AR grade)
(ii) Concentrated sulphuric acid (H_2SO_4—AR grade)
(iii) Concentrated hydrochloric acid (HCl — AR grade)
(iv) Potassium sulphate (K_2SO_4 -AR grade)
(v) Copper sulphate ($CuSO_4$-AR grade)
(vi) Sodium hydroxide (NaOH—AR grade)
(vii) Methyl red indicator
(viii) Methyl orange indicator
(ix) Phenolphthalein
(x) Oxalic acid — (AR grade)
(xi) Sodium carbonate Na_2CO_3 — (AR grade)
(xii) Detergents (Vim/Teepol)

(b) *Apparatus*

(i) Weighing balance (physical and electrical balance)
(ii) Weight box
(iii) Hot air oven
(iv) Muffle furnace
(v) Hot plates
(vi) Micro kjedahl assembly
(vii) Soxhlet apparatus
(viii) Digestion chamber with fume boards
(ix) Volumetric flasks (50, 100, 250, 500, 1000 and 2000 ml)
(x) Beakers (50, 100, 200, and 500 ml)
(xi) Tall Pyrex spoutless beakers (1 litre)
(xii) Conical flask (100 ml)
(xiii) Funnels
(xiv) Round bottom flask
(xv) Pipettes (0.5, 1, 2, 5, 10, and 25 ml)
(xvi) Pair of tongs
(xvii) Moisture cup
(xviii) Silica crucible
(xix) Gouch crucible
(xx) Spatula
(xxi) Tripod stand
(xxii) Wire net
(xxiii) Burette stand with clamps
(xxiv) Pipette stand
(xxv) Muslin cloth
(xxvi) Filter paper (Whatman No 1, 40, 42 and 54)
(xxvii) Test-tube
(xxvii) Test-tube stand
(xxix) Vacuum pump
(xxx) Desiccator

(xxxi) Rubber tubings
(xxxii) Enamel tray
(xxxiii) Glass rods
(xxxiv) Litmus paper
(xxxv) Heater
(xxxvi) Water bath
(xxxvii) Refrigerator
(xxxviii) Water distillation plant
(xxxix) Kjeldahl flask
(xl) Measuring cylinder
(xli) Glass tubing
(xlii) Wash bottles
(xliii) Reagent bottle
(xliv) Spirit lamp
(xlv) Electric wires
(xlvi) Plugs
(xlvii) Tilting bottle
(xlviii) Grinder
(xlix) Pestle and mortar (porcelain iron)
(l) Plastic bottles
(li) Polythene bags
(lii) Paper bags
(liii) Label strips and tags
(liv) Boiling flask (3 litre capacity)
(lv) Conical flask (2 litre capacity)
(lvi) Shelf
(lvii) Cupboard
(lviii) Filing cabinet
(lix) Rubber cork
(lx) Cork borer

19.5 Procedure

— Procure the materials as per item no. 19.4 of this Activity Unit.
— Assemble the equipment wherever necessary and place appropriate places according to their functions
— Store the chemicals on a shelf/ cupboard/store, alphabetically arranged.
— Prepare reagents (refer to Activity Unit 4).
— Keep the record of the consumable and non-consumable articles separately.
— Maintain daily records of the work done.
— Maintain the record of daily consumption of chemicals/reagents.
— Maintain breakage record of glassware.
— Keep complete records of the samples received.

19.6 Observations

The pupil should observe the following :

— Whether the glassware are clean and ready for use.
— Whether chemicals, reagents and samples are properly labelled and kept systematically on their respective racks.
— Whether all the equipment, electric points and water taps are in working order.
— Whether the daily progress of the work is maintained.

19.7 Expected Behavioural Outcomes

The pupil will be able to :	Grade
— identify the laboratory equipment and glassware;	
— organize a feed analysis laboratory;	
— maintain laboratory records.	

The teacher should evaluate the pupil for the above abilities.

19.8 Questions

(i) Why are chemicals kept alphabetically arranged?
(ii) How can electricity, water, gas and reagents be saved?
(iii) What is the importance of quality control?
(iv) How do explosions take place in a laboratory?
(v) Name the hazardous materials used in a laboratory.
(vi) Why is smoking avoided in the laboratory?
(vii) Why is the first-aid box kept in the laboratory?
(viii) How can fumes be effectively removed from the laboratory?
(ix) What is the need of a fire extinguisher in the laboratory?

ACTIVITY UNIT . 20

Visit to a Cattle Feed Compounding Factory

20.1 Instructional Objectives

The pupil should be able to :

- recall common feed ingredients used in the preparation of balanced cattle feed;
- recall compounding of cattle feed;
- observe various processes like grinding, mixing, pelleting, packaging and storage.

20.2 Relevant Information :

Refer to Activity Unit 1, 12 and 13.

20.3 Precautions

- Fix dates and inform the factory well in advance about your visit.
- Do not touch any switches or points in the factory.
- Watch the steps while moving on elevators.

20.4 Materials Required

(i) Record book
(ii) Pencil

20.5 Procedure

- On arrival, contact the reception or factory manager or his representative
- Follow the instructions of the guide from the factory.
- Note down the relevant information.
- Put relevant questions to the guide and seek answers and clarifications as far as possible.
- prepare a report of the visit.

20.6 Observations

The pupil should find out and record the following :

General

(i) Location of the plant
(ii) Capacity of the plant
(iii) Various sections of the feed compounding factory and their coordinated activities :
  - Procurements and storage of feed ingredients
  - Quality control
  - Production and packaging.

— Stores/storage of finished products
— Marketing
— Accounts section

Purchase and stores

(iv) Specifications of raw materials and technical items

Commodity	*Oil and protein* %	*Fibre* %	*Silica* %
Wheat bran	20	8	0 5
Rice polish			

(v) Purchasing system
(a) Brokers/commission agents
(b) Trader/public auction
(c) Govt controlled items

(vi) Feed formulations (note down the least cost computerized formula).

(vii) Shortage of raw material and pellets, if any

Operation and maintenance

(viii) Draw a process and flow of material diagram
(a) Intake section
(b) Grinding section
(c) Batch mixing section
(d) Molasses mixing section
(e) Pelleting section
(f) Bagging section
(g) Boilers

(ix) Precautions to avoid fires and explosions

Quality Control and Feed Formulation

(x) Raw materials used.

(xi) Analysis report and reporting system.

Raw material

Sr No.	*Name of material*	*Code No.*	*Analysis (in percentage)*				
			Moisture	*Crude protein*	*Ether extract*	*Fibre*	*Ash*	*Silica*

Finished Product

Case No. ... .
Date ....

Name of material	*Moisture*	*Crude protein*	*Ether extract*	*Fibre*	*Ash*	*Silica*

Cattle Feed Formula No. ....

Sr. No.	*Material formula*	*% in*	*Crude protein %*	*Ether extract %*	*Crude fibre %*	*Acid insoluble ash*	*DCP*	*TDN*	*Cost Rs/MT*

(xii) Advantages of pelleting feeds vs mesh feed.

(xiii) Feed formulations for various classes and physiological functions.

(a) *Milk replacer*

Protein	25-35%
Fat	5-10%
Carbohydrate	52-53%
Crude fibre	0-1%
Total ash	7-9%
Moisture	5-6%
TDN	90-100%
Vit. A	16000 IU/kg
Vit D_3	2000 IU/kg
Vit. E	20 mg/kg
Vit. B_{12} activity	50 microgram /kg
Antibiotics	60-120 mg

(b) *Calf starter*

Crude Protein	20-25%
Fat	4-6%
Crude Fibre	5-7%
Total ash	9%
TDN	75-80%
Moisture	7-10%
Vit. A	10,000 IU/kg
Vit. D	1250 IU/kg
Antibiotics	60-80 mg/kg

(c) Mesh

(d) Pellets

(xiv) Storage godowns

(xv) Quality control of srored materials

(a) Infestation

(b) Deterioration in quality

(c) Rat or bird problem

(d) Weight loss

(e) Fire hazards

20.7 Expected Behavioural Outcomes

The pupil will be able to

— recall the components of a feed compounding factory;

— comprehend the feed compounding process;

— prepare a detailed report on his visit to the feed compounding factory.

The teacher should evaluate the

Grade

pupil for the above abilities.

20.8 Questions

(i) What are the various sections of the cattle feed compounding factory?

(ii) How is the raw material procured?

(iii) What are the important points in the flow diagram?

(iv) How are quality control reports prepared?

(v) Describe the advantages and disadvantages of mesh vs pellets.

(vi) What do you understand by least cost feed formulations?

(vii) Fill in the blanks ·

(a) The milk replacer contains DCP % ..... TDN% ..... Fibre% ..... Vit. A..... IU/kg.

(b) The calf starter contains DCP% .... TDN% ..... Fibre%..... Vit. A..... IU/kg.

ANNEXURES

ANNEXURE I

Composition of feeds for dairy cattle and buffaloes-Concentrates

Feeds	*Local Name*	*Dry matter* %	*Protein*		*TDN*	*Calcium*	*Phos-phorus* %
			Total %	*Digesti-ble* %	%	%	
Grain							
Barley	Jav	90	8.7	6 9	79	0.06	0.33
Bajra	Bajra	89	11.9	5.1	61	0.12	0.46
Jowar	Jowar	87	15.2	7.3	86	0 12	0.44
Maize	Makki	89	8.9	6.8	81	0.02	0.31
Oats	Jai	89	11 8	8 8	68	010	0.35
Wheat	Gehun	89	13.0	10.1	78	0.50	0.40
Seed							
Cotton	Benola	93	24.9	15.7	91	0 15	0.73
Gram	Chana	88	19.9	14.3	82	0.30	0.36
Guar	Guara	86	34 6	32.2	79	0.27	0.42
Mustard	Sarson	91	13.5	8.8	61	0.04	1.42
Soybean	Soybean	91	36.8	33.1	81	0.25	0.59
Cakes and Meals							
Cotton seed cake	Benola Ki khal	93	41.4	33.5	73	0 18	1.15
Cotton seed-meal	Benola ka chura	91	41.6	33.7	64	0.15	1.10
Groundnut cake	Mungfali ki khal	92	45 8	41.7	80	0.17	0.57
Guar-meal	Guar ka chura	91	43.6	36.8	67	0.70	0.56

Mustard cake	Sarso ki khal	94	33 1	28.5	75	0.84	1.10
Sesame cake	Til ki khal	93	51 5	41 2	75	2.18	1.39
Soybean-meal	Soybean ka chura	90	43 8	37.2	77	0.27	0.63
Sal seed-meal	—	90	9.2	—	41	0 12	0.19
Others							
Gram husk	Chana ka chhilka	—	4 0		55	1.18	0 05
Wheat bran	Gehun ka chokar	89	16.0	12 5	62	0.14	1.17
Rice bran	Chawal ka chokar	91	13 5	8.8	61	0.06	1 82
Molasses	Sheera	74	3.0	1 7	67	0.66	0.08

ANNEXURE II

Composition of feeds for dairy cattle and buffaloes Roughages

Feeds	*Local Name*	*Dry matter (%)*	*Protein*		*TDN (%)*	*Calcium (%)*	*Phosphorus (%)*
			Total (%)	*Digestible (%)*			
Green forage							
Bajra flowering	Bajra	24.2	8 5	4.3	59	0.5	0.31
Berseem flowering	Berseem	15.4	21.0	14.1	60	2.18	0.52
Cowpea flowering	Lobia	14.5	18.9	9.4	58	1.34	0.30
Guar flowering	Guar	17 5	17.5	6.13	49	2.49	0.39
Jowar (Sorghum)	Jowar						
Pre-flowering		16.3	18.7	7 1	53	0.53	0.24
Flowering		21.5	9.7	3.7	56	0.48	0.20
Post-flowering		39.3	4 5	0.7	54	0 32	0.21
Lucerne	Rijka						
Pre-flowering		20 5	24.5	16.0	61	2.30	0.40
Flowering		24.9	20.3	13.9	60	2.30	0.31
Post-flowering		29.9	16 0	13.2	50	1.59	0 27
Maize flowering	Makki	24 1	9.4	5.7	66	0 70	0.32
Metha flowering	Metha	15.5	16.1	—	—	2 06	0.51
Mustard	Sarson						
Pre-flowering		16 7	31 2	25.0	71	0 58	0.56
Flowering		42.5	10.6	8.5	72	0.28	0.50
Post-flowering		45.0	6.3	3.2	68	—	—
Napier	Hathi ghas						
Pre-flowering		14.9	11.0	6.9	63	0.60	0.41
Flowering		23.0	9.2	5.8	62	0.62	0.56
Post-flowering		33.5	7.6	4.8	62	0 62	0.54
Oats	Jai						

Pre-flowering		12 5	12 2	11 3	64	0 60	0 41
Flowering		18 0	8 6	9 2	66	0.62	0 56
Post-flowering		30 0	6 0	6 0	65	0 62	0 54
Senji flowering	Senhi	21 0	19.6	7.91	60	—	—
Hay							
Berseem	Berseem	88.5	14.70	10 3	50 1	1.48	0 28
Cenchrus special	Anjan	—	—	1 71	46 5	0 28	0 21
Cowpea	Lobia	90 5	18 4	12 9	63 0	1.34	0.78
Jowar (sorghum)	Jowar	84 7	7 7	2.9	56 0	0.31	0.21
Lucern	Rijka	88 0	14 0	10 1	50 0	1 13	0.18
Oat	Jai	90 0	6 4	3 1	56.0	0.23	0 21
Kadbi/straw							
Bajra	Bajra	88 0	2 62	0.93	53.4	0.3	0,10
Barley	Jav	88 0	3 6	0 6	43.0	0 3	0,08
Gram	Chana	86.0	3 9	2 4	37 1	1 4	0 16
Jowar	Jowar	91.0	7 0	3.1	51 0	0.74	0 28
Maize	Makki	87 2	5 1	2.2	59.0	0 29	0 11
Paddy	Dhan	91.5	4.2	1 0	48.0	0 24	0 09
Wheat	Gehun	90.0	3.2	0 4	43.0	0.15	0.07

ANNEXURE III

Nutrient requirement of growing cattle (Growth rate 550 g/day)

Live-weight (g)	*DM (kg)*	*DCP (g)*	*TDN (kg)*	*Ca (g)*	*P (g)*
70	2 10	259	1.39	8	5
80	2 33	282	1.53	9	6
100	2.78	328	1.80	12	9
120	3 23	373	2.07	15	11
140	3.67	419	2 34	17	12
150	3 90	442	2.47	20	13
160	4 12	465	2.61	20	13
180	4 57	510	2.88	20	13
200	5.02	556	3 14	20	13
220	5 47	601	3.41	22	15
240	5.97	647	3 68	25	17

ANNEXURE IV

Nutrient requirement of growing buffaloes (Growth rate 450 g/day)

Live-weight (kg)	*DM (kg)*	*TDN (kg)*
70	1 97	1.24
80	2 20	1 38
100	2 65	1.64
120	3 10	1 91
140	3 56	2.18
160	4 01	2.45
180	4 46	2.72
200	4.21	2.98
220	5 36	3.25

Source Nutrient requirement of Livestock & Poultry, Recommendations of the Scientific Panel on Animal Nutrition & Physiology, ICAR, New Delhi, 1982.

ANNEXURE V

Nutrient requirement for maintenance of cattle and buffaloes

Live-weight (kg)	*DM (kg)*	*DCP (g)*	*TDN (kg)*	*Ca (g)*	*P (g)*
250	4-5	140	2.20	25	17
300	5-6	168	2 65	25	17
350	6-7	195	3.10	25	17
400	7-8	223	3.55	28	20
450	8-9	250	4.00	31	23
500	9-10	278	4 45	31	23
600	11-12	336	5.35	31	23

ANNEXURE VI

Requirement of nutrients per kg milk production

Fat (%)	*DCP (g)*	*TDN (g)*
3.0	48	275
3.5	51	300
4.0	55	325
4.5	58	350
5 0	62	375
5.5	65	400
6 0	68	425
6 7	72	450
7 0	75	475
7 5	79	500

Note . 2.8 g calcium and 2 0 g phosphorus should be provided per kg of milk produced

ANNEXURE VII

Composition of concentrate mixture for dairy animals

Feed (kg)	*Percentage in the concentrate mixture*									
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Groundnut cake	—	28	20	—	20	17	22	15	—	20
Wheat bran/rice bran	57	27	25	30	41	20	25	45	42	—
Moong/gram/urad *Churies*	—	—	25	20	—	—	—	37	37	17
Maize/barley/oats	—	42	—	27	26	40	10	—	—	20
Wheat/rice grit	—	—	27	—	—	—	30	—	—	20
Maize gluten meal	—	—	—	20	—	—	10	—	—	—
Guar-meal	15	—	—	—	10	—	—	—	—	—
Sarson cake	25	—	—	—	—	—	—	—	20	—
Cotton seed cake	—	—	—	—	—	20	—	—	—	20
Mineral mixture	2	2	2	2	2	2	2	2	2	2
Salt	1	1	1	1	1	1	1	1	1	1
DCP	18.0	17 5	16.0	13 0	18 0	15.0	16.5	16 0	15.0	17.0
TDN	65 0	73 0	69.0	69 0	69.0	71.0	72.0	63.0	66.0	72.5

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